S. HRG. 100-754

PROPOSED FISCAL YEAR 1989 BUDGET REQUEST (DOE's Renewable Energy and Energy Conservation Programs)

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

SECOND SESSION

ON THE

DEPARTMENT OF ENERGY'S FISCAL YEAR 1989 BUDGET REQUEST FOR RENEWABLE ENERGY AND ENERGY CONSERVATION PROGRAMS

MAY 18, 1988

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PROPOSED FISCAL YEAR 1989 BUDGET REQUEST

(DOE's Renewable Energy and Energy Conservation Programs)

WEDNESDAY, MAY 18, 1988

U.S. SENATE,
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:02 p.m., in room SD-366, Dirksen Senate Office Building, Hon. Wyche Fowler, Jr. presiding.

OPENING STATEMENT OF HON. WYCHE FOWLER, JR., U.S. SENATOR FROM GEORGIA

Senator FOWLER. This is the hearing of the Subcommittee on Energy Research and Development of the Committee on Energy and Natural Resources to assess the administration's fiscal year 1989 budget for the Department of Energy's renewable energy and conservation program.

We are here to explore whether this budget will meet our long-term needs for renewable energy and conservation research and development, whether it is consistent with the sound overall energy policy for our country. And of course, we need to try to make that determination knowing that what we have seen in recent years is a lagging investment, a shortfall in our future preparedness to meet our energy needs whether it be transportation, industrial, business and residential use.

I will submit a complete statement for the record in the interest of time, and also that of my colleagues, Senator Ford of Kentucky, and Senator Wirth of Colorado.

[The prepared statements of Senators Fowler, Ford, and Wirth follow:]

Conservation and Renewable Energy Hearing
Opening Statement by Senator Wyche Fowler, Jr.
May 18, 1988

We are here today to assess the Administration's fiscal year 1989 budget for the Department of Energy's renewable enrgy and conservation programs. Does this budget meet our long term needs for renewable energy and conservation research and development? Is it consistent with a sound overall energy policy for our country?

We need to try to make that determination, knowing that what we have seen in recent years is lagging investment, a shortfall in our future preparedness to meet our energy needs in transportation, industrial, business and residential use.

We have to make that determination knowing that dependence on foreign energy sources remains unchanged as the most critical problem looming on the horizon. Past Administration budgets have not averted this crisis, or even addressed it in this senator's view.

We have even seen attacks on some of the conservation projects that proved so successful in the 70s. With reliance on imported oil our number one energy problem, this administration has sought to roll back fuel efficiency standards for automobiles. In the meantime, oil imports are projected to rise to over 60 percent in the 1990s.

There may be some argument over how much oil is left in the world. But not even the strongest ideologue can suggest that the percentage of the remaining supply under U.S. control will not dwindle as the years go by. It is essential that we find a replacement for oil as an energy source -- especially in transportation, which accounts for 65 percent of our consumption.

I am afraid the budget we will examine today continues this trend toward the elimination, the ill-advised elimination of research and development programs in areas that hold the greatest promise. The long decline in solar funding continues. The Administration proposal for energy conservation research and development is 45 percent below FY 1988 appropriations -- even though all indications, and the testimony we will hear today I'm sure, show that conservation programs have succeeded beyond expectations in reducing energy consumption.

There has been little we can do to reassert and reestablish our priorities in the face of today's outrageous budget deficits. I have called for a modest investment in renewable research and development in a bill I introduced last year, S. 1554. This bill would establish three-year

funding authorization levels for renewables -- because I believe that we cannot allow these initiatives to languish while we relinquish our lead in wind technologies to the the Dutch, to the Japanese in solar and photovoltaics.

I also believe that renewables and conservation are the energy sources for a secure future. These are sources that will not confront us with periodic supply problems, which foreign nations cannot control as long as we possess the technology. These will make us less vulnerable economically, and these sources are safer environmentally than anything in wide use today.

We have many technologies ready to develop and market -- particularly in solar and biomass -- if we will move ahead tc prepare for the long run. The present cheap and plentiful supplies of oil should not make us complacent. We already know from experience how quickly that can turn around on us, and we can see by our forecasts that we will not see this situation through to the end of the next decade.

We can improve performance of renewables to become competitive with conventional sources, and eventually to take over. Instead of pushing forward, we have eroded support. I think we have to look at proposed budgets with a view toward reversing this trend.

It is not the job of the private sector to ensure our national security, or to entertain questions of foreign policy related to our energy supply. The private sector, by itself, cannot provide the financial incentives or set our priorities for sustainable energy supplies into the next century. That is our job.

I want to thank the many members on this committee who have supported my legislation aimed at improving the long term performance of DOE renewable energy and conservation programs. I believe we have to accelerate our efforts, and elicit more vigorous industry support, to provide fiscally sustainable programs for stable and secure sources of energy in the year 2000.

And I am interested in hearing the opinions of these experts, who have been good enough to give us their time this afternoon, whether the Administration budget we have before us sets America on this course and will help us achieve this goal.

STATEMENT OF SENATOR WENDELL H. FORD

Hearing on FY 1989 Budget
for Renewable Energy and Energy Conservation Research and Development

Subcommittee on Energy Research and Development

May 18, 1988

I congratulate Senator Fowler for this hearing. As vice-chairman of the Subcommittee on Energy Research and Development, he has been a champion of renewable energy and energy conservation. I know that the testimony that will be received today will, under his guidance, become a record in support of responsible and forward looking policies for these very important elements of our energy mix.

You will have to do some work with the Administration testimony. The preamble is there as it relates to recognition of the importance of energy conservation in reducing our need for imported oil. But there is no follow through.

It is the same old story. Tell us about the importance of energy conservation.

Then cut the budget - this year by 45%.

Tell us about the potential of renewable energy technologies that, according to the Administration's testimony, are

> "poised to make vital contributions to electric power generation, industrial process heat requirements, solid, liquid, and gaseous fuel needs, and the cooling, lighting and heating of buildings".

Then cut the budget - this year by 17%.

Well, we have cut the budget. Federal support for renewable energy and energy conservation research and development is far below what it was when the decade of the 1980's began. In fiscal year 1981 we appropriated $557 million for renewable energy research and development. Last year we appropriated $97 million. The budget has been cut.

But there has been no real effort to establish a sustainable program at these lower funding levels to develop the energy conservation and renewable energy technology we will need.

That will be the task of the new Administration. In the present climate of budget deficits we are unlikely to return very soon to $557 million for renewables. But the promise of renewable energy technologies requires that we have a research and development program in renewables, at whatever level we decide to afford, that is headed somewhere. We don't have such a program now.

This Administration is not interested in providing such a program.

So we in Congress will do our part. We will try to provide extra resources above what the Administration has requested for renewable energy and energy conservation research and development. But we need more than the small increases in funding that we may be able to squeeze out of the process. We need the leadership for these technologies from the Administration - the leadership that has been missing these past seven years.

STATEMENT OF THE HONORABLE TIMOTHY E. WIRTH

Mr. Chairman, I appreciate the opportunity to join you in reviewing the President's final budget request for energy conservation and renewable energy research and development programs. When this administration began, we were investing substantial resources into these programs. The oil price shocks of the 1970's forced this nation to recognize that our dependence on foreign sources of oil is a threat to the security of this nation and its economy. We also realized that it was time to roll up our sleeves to respond to the challenges of an energy future based on greater independence. So we set the nation's research community and federal agencies to work to reduce our dependence of foreign energy supplies -- particularly imported oil. The result of that effort is nothing short of astounding.

Improvements in energy efficiency have leveled off the nation's energy consumption. Today, we use the same amount of energy as we used in 1973, despite enormous growth in our economy. And the United States took the lead in developing alternative sources of energy, including promising solar energy technologies. Unfortunately, the impressive gains that have been derived from energy conservation and renewable energy research and development are being threatened by budget priorities that favor nuclear r&d and long-term, high-risk programs over common sense research that will contribute to our efforts to reduce the trade deficit, enhance our competitiveness and protect the environment.

In its eighth year, this Administration is proposing to continue its efforts to slash the federal commitment to the future of energy conservation and renewable energy. Consequently, this nation faces the risk of reversing the gains made in energy efficiency and renewable research and development.

When this administration came into office, we were spending more than $500 million on solar and renewable research programs. This year's budget is requesting funding for these programs at $84.5 million. Similarly, this administration began with a budget for energy conservation research and development of $343 million. In its final year, the administration wants to leave us with an energy conservation research program funded at $86 million. We must ask ourselves: why have we cut these programs 85 percent and 75 percent respectively.

Have these programs been sacrificed in order to balance the federal budget? Have we realized the full benefits of energy conservation and renewable energy supplies? Has the private sector taken over leadership of the nation's energy research and development? The answer to these questions can only be no.

If we do not reverse this trend toward reducing the critical investments we must make for future generations, we will have to apologize to our children and grandchildren. For example, the U.S. world market share in photovoltaics has dropped from 80 percent in 1981 to 50 percent this year. And our international competitors, such as Japan and West Germany, have responded with increased expenditures on photovoltaic research and development. We must take a sober look at

today's budget realities and readjust our priorities to invest in energy efficiency improvements and renewable energy.

Energy efficiency, solar energy and other renewable energy technologies can enhance our industries' competitiveness in international markets and can help improve the nation's balance of trade by reducing the need for imported oil. And as atomospheric scientists from around the world are sounding an alarm about the potentially profound threat of global warming, it is becoming increasingly clear that energy efficiency and alternatives to fossil fuels must be found to preserve and protect our environment.

I look forward to working with members of the subcommittee in developing a comprehensive national energy policy that emphasizes the critical importance of energy conservation and alternative sources of energy. I thank the witnesses for testifying before the committee about these important programs and I thank you, Mr. Chairman, for your leadership in these matters.

# # #

Senator FOWLER. We are pleased to lead off today with the Assistant Secretary for Conservation and Renewable Energy Programs of the Department of Energy, the Honorable Donna Fitzpatrick. Secretary Fitzpatrick, thank you very much for being with us again.

I see you've got a statement appropriate for the appropriations committee in its thoroughness and persuasiveness. But if you would submit that to the record, and summarize your testimony, I think we won't delay everybody too long today.

STATEMENT OF DONNA R. FITZPATRICK, ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY, DEPARTMENT OF ENERGY

Miss FITZPATRICK. Thank you, Mr. Chairman. I do have a very short statement I would like to make now besides submitting the formal statement for the record.

I appreciate the opportunity to appear before the subcommittee today to provide information on our fiscal year 1989 budget request for conservation and renewable energy research programs.

The budget for these programs is consistent with and supports the goals and objectives of the national energy policy and is fully responsive to administration and congressional goals for deficit reduction. In support of these strategies, we are requesting $55.7 million for energy conservation research and development programs under this committee's jurisdiction, and $8.6 million for state and local assistance programs, $124.8 million for renewable R&D.

The budget was developed based upon our multiyear program plans for each of the energy conservation and renewable energy technology programs. The approach used in those plans is one in which we set a goal for each program—that is, a goal of economic competitiveness—and then carefully develop, along with the relevant industry and research community, a plan to accomplish the goal. We then use these plans to develop a prioritization of our research needs and to allocate the available budget resources.

The budget request to implement these plans is not a generous one, but it is within the current Federal budget limitations. We concentrate our efforts on the highest priority research to address the most critical scientific and technological issues. We believe that this will provide effective programs that will accomplish our program goals.

We also continue to focus on improved dissemination of the results of our R&D programs and on expanded collaboration with the private sector.

The research sponsored by the Federal Government and private companies over the last decade is now bearing fruit in better materials and improved components and systems designs to increase energy efficiency and to make alternative energy sources reliable and economically competitive. Now we must look to the future and pursue those activities which will slowly but surely expand and improve our energy use and supply options. The way out of our energy problems in the long run must be through better technology, to improve both utilization efficiency and supplies of every kind, and the only way to better technology is through research.

Here is where there are some crucial decisions to be made and where the Congress and the Department of Energy can work together because we need to work to assure that every dollar appropriated for R&D is spent productively. If we are going to spend more than requested, then let's at least spend it on justifiable reviewed work that actually advances the national interests. If we do that, we can turn our budget limitations into an opportunity to bring more discipline and high quality work to our research programs. The days of the add-ons that nobody really minded are gone because those projects are no longer add-ons; they are substitutions for work that has been reviewed and justified in terms of national interest. We need to work together to form a consensus because if we do not, we are going to see our total R&D budget continue to shrink and the truly productive part will shrink even faster. It is important that the decisions that we make truly move the Nation toward greater energy efficiency and broader availability of supply choices rather than just expanding the Federal conservation and renewable energy budget.

Therefore, Mr. Chairman, we would like to invite you and the subcommittee to review our multiyear plans, which we have delivered to you, and to give us your comments. Tell us that we are on the right track or tell us that we are way off but, most of all, we need your help in doing our job of supporting the best and most productive R&D for energy efficiency and renewables.

Mr. Chairman, I appreciate the opportunity to appear here today and to gain your advice on these matters. And I'd be happy to answer any questions you may have.

[The prepared statement of Miss Fitzpatrick follows:]

STATEMENT OF

DONNA R. FITZPATRICK

ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY

U.S. DEPARTMENT OF ENERGY

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

SUBCOMMITTEE ON ENERGY RESEARCH & DEVELOPMENT

U.S. SENATE

MAY 18, 1988

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to appear before you today to provide information on the FY 1989 budget request concerning the Department's Conservation and Renewable Energy programs. The budget for these programs is consistent with the goals and objectives of national energy policy and is fully responsive to the Administration and Congressional goals of deficit reduction.

I would now like to discuss each of our major program areas under your jurisdiction and its related FY 1988 funding request.

BUDGET REQUEST FOR ENERGY CONSERVATION R&D

The FY 89 budget request for energy conservation research and development programs under this subcommittee's jurisdiction totals $55.7 million. It includes $28.4 million for Transportation, $11.6 million for Buildings and Community Systems, $16.5 million for Industrial Programs, and $24.2 million for Multi-Sector programs.

BUILDINGS AND COMMUNITY SYSTEMS

We are requesting $11.6 million for Buildings and Community Systems (BCS) research, development and technology transfer in FY 1989. Of the funds requested, $9.1 million are for research and development projects and $2.5 million are for program direction. The R&D activities focus on selected high-risk and high-payoff projects, which are not likely to be pursued by the private sector alone. Many are carried out by private

companies and institutions operating under cost-shared contracts or cooperative agreements with the Department. These activities complement industry efforts and do not displace them.

The Buildings sector uses approximately 27 quads of energy annually, 36 percent of our total national energy consumption. This energy use is forecasted to increase to 39 quads by 2010. In residential buildings, space heating, water heating, and refrigeration use the largest amounts of energy; in commercial buildings, space heating, lighting, and air conditioning use the largest amounts. It is estimated that a 30% reduction from present levels of energy use can be achieved by building envelope improvements that reduce heating, ventilating, air-conditioning, and lighting loads and that significant additional savings can be achieved by improving the efficiency of equipment used to perform these and related building functions. Our target is to reduce building energy use in 2010 to 28 quads - a savings of 11 quads from presently forecasted levels. The Buildings and Community Systems program conducts research to advance the technologies that can produce these savings and makes the results of that research available to the private sector. This program also implements building energy regulatory activities mandated by Congress.

The research and development funds are for three subprograms: Building Systems, Technology and Consumer Products, and Technology Assessment and Transfer. We are requesting $2.8 million for the Building Systems subprogram to continue research in building materials, roofs, fenestration, indoor air quality, infiltration, and ventilation; advanced commercial building

subsystems interactions; building performance simulation; and residential building energy retrofit.

Our building materials research will focus on foamed insulation using non-CFC blowing agents; our fenestration research includes development of design tools, and, in cooperation with ASHRAE, window evaluation procedures.

Our roof research focuses on improving the energy performance and durability of roofs. In FY 1989, we will continue to equip and operate the Roof Research Center as a DOE user facility with industry participation. Research areas will include effects of stress and dynamic cycling of moisture on thermal performance of roofs, field testing of moisture measurement techniques, and assessments of light weight concrete and polyurethane foam roofs. These activities will be conducted in cooperation with the roofing industry.

In FY 1989, we will continue our investigations of ways to maintain acceptable air quality in energy-efficient buildings. These efforts will include continued studies of radon entry and energy efficient radon mitigation methods. We will continue to participate in interagency and private sector efforts to develop standards for indoor air quality, infiltration and ventilation. We will continue our studies of indoor air quality in office buildings, including measurements of volatile organic pollutant levels.

In the area of building subsystem interactions, we will continue development and industry review of building energy targets methodology for commercial buildings. We will continue to maintain the DOE-2 building energy performance

simulation computer code and will incorporate new capabilities developed by others.

We will complete analysis of data from the monitoring of single-family retrofits and disseminate the results to users. We will complete development of the handbook for energy audits of multifamily buildings and of the methodology for measuring energy savings resulting from retrofits for low income housing.

We are requesting $4.3 million for the Technology and Consumer Products subprogram in FY 1989. The purpose of this research is to provide technologies needed to develop more efficient building energy conversion processes and equipment. The greatest promise for significant energy savings in building equipment is in heating, cooling, and lighting--areas that account for more than 60% of the energy used in buildings. Our work on improved efficiency in those areas focuses on thermally activated heat pumps, advanced refrigeration, and advanced lighting.

In thermally activated heat pumps, we will continue research to advance the technologies for absorption systems. We will continue laboratory testing and evaluation using breadboards of two advanced systems concepts for commercial-size and one packaged prototype of a residential-size absorption heat pump and will fabricate a residential-size engineering prototype for field testing. We will also continue testing of a laboratory prototype internal combustion engine-driven heat pump and will build two engineering prototypes for field testing.

In advanced refrigeration systems, we will continue research in nonazeotropic refrigerant mixtures, including benefits of composition shifting and advanced cycle concepts, and will complete research on capacity modulation.

In lighting equipment research, we will continue to investigate advanced light sources with emphasis on magnetically loaded fluorescent lamps, surface wave lamp phenomena, and electrodeless high intensity discharge (HID) lamps. We will initiate long term tests of isotopically enriched mercury lamps.

The purposes of the Technology Assessment and Transfer subprogram are to provide the analytic tools and information needed for program planning and to ensure that research results and information on conservation in buildings are transferred to potential users. We are requesting $1.0 million for this subprogram. This funding will continue support for centralized BCS technology transfer activities, for technology assessments and program planning, and for participation in International Energy Agency agreements.

We are requesting $1.0 million to provide capital equipment to support those Buildings and Community Systems research efforts conducted by the national laboratories and universities. In addition, we are requesting $2.5 million for Program Direction. This funding will provide salaries, benefits, travel, and support of 45 FTEs to manage the Buildings and Community Systems program.

TRANSPORTATION

The FY 1989 budget request for the Transportation program is $28.4 million. This will continue R&D in five major program areas: Vehicle Propulsion;

Alternative Fuels Utilization; Electric and Hybrid Vehicles; Advanced Materials Development; and Technology Assessment and Transfer. The overall objective of these programs is to support long-term, high-risk, but potentially high-payoff R&D on promising transportation energy conservation technologies that are unlikely to be undertaken by the private sector alone.

The transportation sector uses a quarter of all energy in the United States and over 63 percent of all petroleum. The goal of the transportation conservation program is to improve the efficiency with which the sector uses petroleum and to enhance the flexibility of fuel use options in transportation related technologies. This goal is underscored by the fact that such technologies have potentially significant leverage on the U.S. and world oil situation. Reductions in U.S. transportation oil use can enhance energy security, reduce oil imports and related trade payments to foreign countries, and enhance economic growth. These programs provide the technology base necessary to support private sector efforts to develop technologies which are either more efficient or serve as alternatives to those based exclusively on petroleum.

In FY 1989, $6.9 million is requested for the Vehicle Propulsion R&D program which supports research and development of high efficiency and advanced heat engine technologies. This area includes R&D on advanced engine concepts, including the automotive gas turbine and the heavy duty adiabatic (low heat rejection) diesel engines. The objectives for both engines are to achieve at least a 30 percent improvement in fuel efficiency over conventional current production heat engines, meet or exceed established requirements for regulated

emission levels, and operate satisfactorily on a variety of fuels. Funds will be used to develop and evaluate high temperature structural ceramic components for automotive gas turbine engines and to conduct research on temperature combustion and emissions for adiabatic diesel engines.

In FY 1989, $1.6 million is requested for the Alternative Fuels Utilization program which fosters the use of nonpetroleum-based transportation fuels by establishing a technology data base for utilization of synthetic, biomass-derived, and gaseous fuels in both contemporary and advanced heat engines. These funds will be used to investigate performance, emissions, and wear with advanced and conventional engines using synthetic fuels; operate a synthetic test fuels facility; investigate basic combustion phenomena to existing engines using minimally upgraded syncrudes; and collect and analyze methanol fuel use data from the Federal fleet.

In FY 1989, $5.6 million is requested for the Electric and Hybrid Vehicle program which addresses the need for improved range, reliability, cost, and performance of electric and hybrid vehicles, giving priority to accelerating technologies to a level suitable for private sector decisions to produce specific-purpose vehicles. These funds will be used to continue the development of sodium-sulfur, zinc-bromine, and lithium-metal sulfide batteries to prove the capability of full battery subsystems to function properly in a vehicle including typical environmental, shock, and vibration conditions, and realistic electric vehicle driving profiles. Funds will also

be used to complete the dual-shaft a.c. propulsion system, which includes the development and vehicle integration of the nickel-iron battery technology, and to test and evaluate batteries and powertrain technologies.

In FY 1989, $9.9 million is requested for the Advanced Materials Development program. This area addresses the need to develop an industrial technology base in structural ceramics, ceramic composites, and coatings capable of providing reliable and cost-effective components for high temperature, efficient transportation propulsion systems while eliminating requirements for scarce strategic materials. The funds will be used to continue research projects in materials and processing, e.g., low expansion ceramics, ceramic coatings, joining of ceramics and advanced processing of reliable monolithic ceramics; projects in design methods, such as characterization of contact stress coatings and modeling of brittle fracture; and projects in data base and life prediction, including development of tensile strength test methods, and characterization of time-dependent strength properties. To support the advanced materials work conducted under this and other research programs, a user-oriented High Temperature Materials Laboratory has been constructed at the Oak Ridge National Laboratory. Two million dollars are requested to support the scientific staff dedicated to the Laboratory's user facilities and to building maintenance and operations.

In FY 1989, $1.0 million is requested for Technology Assessment and Transfer. This program centralizes cross-cutting functions such as the identification, monitoring, review, and assessment of related industry and market trends; transfer of information on technologies developed; publication of statistical

compendiums; and management and planning support. The funds will be used to collect, analyze, and present transportation and energy data including market conditions for fuel efficient technologies; provide consistent baseline projections of the demand for transportation energy by mode for use by program managers in program planning and monitoring; and conduct vehicle propulsion technology assessment and transfer activities.

We are requesting $1.4 million for Program Direction. This funding will provide salaries, benefits, and travel for a staff of 22 FTEs to manage the Transportation programs.

MULTI-SECTOR

The Multi-Sector Program includes the Energy Conversion and Utilization Technologies (ECUT) Program, the Inventions and Innovation Program, and the National Appropriate Technology Assistance Service (NATAS). The FY 1989 budget request for Multi-Sector includes $17.6 million for ECUT, $4.65 million for the Inventions and Innovation Program, and $0.6 million for NATAS. The budget request also includes $0.1 million in capital equipment, $0.475 million in program direction to support 8 FTEs for Multi-Sector programs, and $0.732 for Technology Assessment and Transfer. The total Multi-Sector budget request for FY 1989 is $24.157 million.

ECUT Program research activities are interdisciplinary in nature. ECUT seeks to capitalize on basic research breakthroughs to address "real world" problems which cut across more than one energy consuming sector. ECUT research results in improved understanding of materials problems and also provides predictive

models and design tools useful to the private sector for achieving greater energy productivity. The ECUT interdisciplinary technical areas are: Combustion, Thermal Sciences, Materials, Biocatalysis and Tribology. In addition, funding is requested for International Research Monitoring and Conservation Program Analysis and Planning which are conducted on behalf of the overall DOE Conservation Program.

In FY 1989, $3.6 million is requested for the ECUT Combustion Program and $1.5 million for the ECUT Thermal Sciences Program. ECUT Combustion research provides analytical and measuring techniques needed to understand the thermochemical and related processes that take place in the combustion of fuels and in the conversion of the released thermal energy to perform work. The results of this research are used to develop more efficient, reliable, and clean combustion systems and devices.

ECUT Thermal Sciences research develops improved thermodynamic and fluid dynamic analytical capabilities and experimentally validated computerized data bases. These are needed to provide the technological heat transfer surface area requirements, and improve the efficiencies of a wide variety of energy conversion processes. In FY 1989, the work will emphasize the development of advanced thermodynamics, fluid mechanics, and heat and mass transfer.

The $6.7 million requested for the ECUT Materials Program will be used to continue to investigate energy conservation applications of the new high critical-temperature superconducting materials, and other high-temperature materials (new and different ordered metallic alloys and ceramics); to pursue

research on recycling polymers (lightweight materials); and to actually attempt to design a ductile ordered alloy prior to its being made in the laboratory. In the last regard, we are especially excited by our results which appear to explain why the addition of a small amount of the element boron to the ordered intermetallic alloy nickel aluminide renders ductile this formerly highly brittle material. More importantly, this insight appears to permit us to extend this knowledge to design ductility into new ordered alloys prior to their ever being made in the laboratory. This capability to design desired properties into alloys could have major implications for the international competitiveness of an important segment of the U.S. metallurgical industry.

The $2.6 million requested for the ECUT Biocatalysis Program will be used to establish a technological data base for high productivity bioreactors needed by private industry in order to manufacture industrial and commercial chemicals using biological systems which are economically and energetically competitive with conventional processes.

The $2.6 million requested for the ECUT Tribology Program will be used for research on high-temperature lubricants, development of in-situ friction and wear diagnostic instrumentation, and for engineering tribological surfaces.

Other ECUT funding requested in the FY 1989 budget--$0.4 million--will be used to continue to assess the status of foreign technologies related to energy conservation and to compare it with the status of U.S. technologies. The request of $0.4 million is for supporting analyses, such as updating the

Conservation Multi-Year Plan, and other necessary analyses and assessments conducted on behalf of multiple sectors of the DOE Conservation program. The FY 1989 budget request for the first time consolidates Conservation program resources for these cross-cutting activities within the Multi-Sector budget request. The request of $0.1 million for capital equipment will be used to provide advanced instrumentation for research in combustion technology.

The FY 1989 budget requests $4.65 million for the Inventions and Innovation Program. The Energy-Related Inventions Program was established by Congress to evaluate the technical merits of energy-related inventions submitted to DOE and to provide technical assistance and grants to further develop promising inventions. The National Bureau of Standards (NBS) conducts evaluations through its Office of Energy-Related Inventions. Promising inventions identified by NBS are directed to DOE which may elect to provide Federal assistance when private sector support is not available. From program inception in 1974 through 1987, approximately 24,000 disclosed inventions have been evaluated by NBS. Based on NBS recommendations, 280 inventors have been awarded grants totaling $20.2 million. Of these, at least 73 have entered the marketplace, generating estimated cumulative sales of $220 million and directly creating more than 495 jobs. In FY 1989, the requested funding will support the analysis of approximately 1,000 inventions, and provide financial support for approximately 35 of the most promising inventions. During FY 1989, DOE will continue to work one-on-one with inventors to provide commercialization planning assistance and will conduct group workshops which we have found to be very helpful to inventors in dealing with the various aspects of bringing these technologies to the marketplace.

In FY 1989, the Inventions Program will continue to identify and evaluate the activities of existing local, state, and regional programs which are working directly with inventors and determine the extent and success of efforts being conducted by the private and non-Federal public sector to foster technological innovation. In addition, the effort will establish procedures with states that have innovation support programs to permit the exchange of information and provide for shared support of selected inventions. Beginning in FY 1989 these activities are funded as part of the Technology Assessment and Transfer budget element.

Over the past six years the Innovative Concepts Program has provided seed money to conduct preliminary energy and economic assessments of innovative approaches to saving energy in the area of building materials, industrial processes, and separations. Awards of approximately $15,000 were made to each of 32 contractors selected from responses to RFPs on these targeted topics. In FY 1989, the Innovative Concepts Program will continue to conduct limited tracking of these contractors in order to determine how many received follow-on funding, how many new businesses were started, how many patents were issued as a result of funding by this program, and whether the approach that we developed is being used as a model at national laboratories to encourage innovation and creative solutions to energy conservation problems. An analysis will be completed of inventors who hold nine or more patents in three or more fields. The purpose of the study will be to determine how to encourage participation by these prolific, versatile inventors in DOE's Inventions and Innovations Programs.

In 1983, the Congress appropriated funds to establish the National Appropriate Technology Assistance Service, the third Multi-Sector program, to disseminate information on conservation and renewable energy technologies and to give expert advice and guidance in using them effectively. NATAS was formally established in FY 1984, and to date has received over 28,000 requests for information and assistance. The FY 1989 Budget Request contains $0.6 million for NATAS for continuation of information and technical assistance to individuals and energy-related businesses.

Prior to the FY 1989 budget request Technology Assessment and Transfer activities were incorporated in the requests for the ECUT and Inventions programs. In FY 1989, $0.732 million is identified to conduct the monitoring of inventors supported by the Energy-Related Inventions Program, to provide technical and analytical support for management of the ECUT and Inventions programs, as well as to support the Inventions program activities with inventor organizations earlier described.

INDUSTRY

The FY 1989 budget request for the Office of Industrial Programs is $16.452 million. These funds will be used to carry out work in generic research and development in four subprograms: Waste Energy Reduction, Industrial Process Efficiency, Industrial Cogeneration, and Implementation and Deployment. The goal of these activities is to encourage improved energy efficiency in industry, which accounts for approximately 36 percent of total U.S. energy consumption, and to provide technologies which offer industry a choice of fuel

options. The Department's activities in the industrial area consist of a comprehensive program of carefully targeted technological research and development, combined with technology transfer and other implementation efforts. The R&D activities focus on selected high-risk and high-payoff projects which are not likely to be pursued by the private sector alone. However, most of the R&D is carried out by private companies and institutions operating under cost-shared contracts or cooperative agreements with the Department of Energy.

The Waste Energy Reduction subprogram supports research and development on improved combustion efficiency for industrial furnaces, boilers, and process heaters through oxygen enrichment, improved burner designs, and sophisticated combustion controls. The subprogram also supports R&D on waste heat recovery by development of industrial heat pumps, high temperature recuperators, and ceramic materials for heat exchangers; and research into industrial waste materials recovery and utilization. An example of this research is the development of a pure low cost silicon carbide powder for making heat exchanger components to reduce the cost and improve the reliability of high temperature recuperators. An offshoot of this work was the development of non-destructive evaluation techniques to determine the integrity of fabricated ceramic parts which are placed in high temperature service. A private company which worked with INEL under a DOE contract now offers this inspection service to ceramic part fabricators. In FY 1989, $6.5 million is requested for this subprogram to continue these kinds of activities. In addition to the continuation of ceramic material development, particularly with reinforced fiber materials, efforts will be continued on advanced concepts for heat

exchangers, new types of chemical heat pumps for industrial process applications, and the advancement of technologies to utilize wastes through the use of chemical and biotechnology processes.

The Industrial Process Efficiency subprogram includes R&D for advanced sensors and control systems; advanced separation systems; development of electrode materials; and testing for process electrolysis. Significant progress is being made in several of these areas and continuation is planned for FY 1989. The development of stable anodes and cathodes for the electrolytic production of aluminum offers great promise in reducing the electrical power requirements for the process and the effort is now being scaled up to a 6,000 ampere pilot cell. If successful, the process will be further scaled to a full size aluminum production cell. The request also includes research and development of new on-line industrial sensors for improved control of a multitude of industrial processes, advanced low energy separation processes using techniques such as membranes, electroacoustic dewatering, continuous liquid chromatography, impulse drying of wet web materials such as paper, and freeze separations. All of these efforts offer excellent opportunities to reduce the energy consumption in basic industrial processes. Funding of $6.1 million is requested for this subprogram.

No funds are being requested for the Steel Initiative in the FY 1989 budget request because $9.3 million is available for new project efforts. The magnetic levitation work that was underway at the Argonne National Laboratory was terminated after the Steel Industry decided not to support further development. A project for the development of superplastic steel is presently

being negotiated with Lawrence Livermore National Laboratory. This project offers the possibility of producing net-shape components with large monetary and energy savings, because machining, joining, and special heat treating procedures could be eliminated.

The Industrial Cogeneration subprogram focuses on research for cogeneration technologies, such as topping cycles, bottoming cycles and the direct conversion of thermal to electrical energy which can be part of either a topping or a bottoming cycle. This program has been very successful in promoting cogeneration technologies which utilize alternative fuels. For example, the development of a coal-water slurry fired slow speed diesel was successfully completed under this program. The program overcame the difficulties of fuel handling and injection and obtained sustained running of the test engine with very low emissions. The IP research will continue on the indirect-fired Brayton system, the high temperature steam turbine system and the alkali (sodium) heat engine. In FY 1989, $0.8 million is requested to continue the sodium heat engine research to upgrade the design of a 1,000 watt test unit built to industrial specifications.

In addition to its research and development efforts, the transfer of technology to industry remains a principal objective of DOE's industrial conservation program. Examples of recent technology transfer efforts include workshops on CO_2 recovery and separation technologies, as well as preparation of technology transfer documents on ceramic research, steel industry research and development, and sensor work. Economics is the main incentive that industries have for adopting more energy-efficient technologies, therefore,

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the technology transfer effort is designed to focus attention on the economic benefits associated with specific technologies. Trade associations are typically involved in industrial technology transfer efforts, helping to multiply the effects of the Department's own efforts to match technology with potential users. In FY 1989, $1.462 million is requested for this subprogram. Work will focus on workshops, seminars, and technical symposia and the development of written materials focusing on technologies developed with DOE assistance. This budget category will now include funding for technical evaluation, analysis, and planning support for the total program. This was formerly included in the Waste Energy Reduction Subprogram.

The technologies being developed by the Office of Industrial Programs, if successfully brought into production, can provide U.S. industry with important improvements in productivity and help to regain technical leadership positions vital to our success in world markets.

RENEWABLE ENERGY OVERVIEW

The Nation's overall national energy program is built upon broad policy goals -- improving national security, assuring an adequate, stable supply of energy at reasonable costs, and protecting public health and safety and environmental quality. The reliability of an adequate supply of energy impacts day-to-day functions of the entire public and private economy of the nation. Energy is and will remain a vital ingredient in the competitiveness of the country's goods and services in domestic and foreign markets. The nation has made important strides over the past several years towards an improved energy

security through increasing the efficiency of energy use and diversifying its sources of energy supplies. Important areas of energy opportunity remain; the ability to build upon these successes will make the critical difference in the Nation's energy, and therefore economic future.

An energy economy that depends largely on imported commodities such as oil or gas can be subject to short term volatility and a large degree of potential uncertainty in response to national or international economic and political forces. But our energy economy is shifting steadily toward reliance on improved technology rather than abundant commodities. Research sponsored by the Department and the private sector will lead to the technologies needed to allow economic access to domestic oil supplies and clean burning of coal. Improved technology is already allowing us to exploit non-commodity energy supplies by decreasing the costs and increasing the efficiency and reliability of the many types of solar, geothermal, and biomass energy systems. These systems are typically capital intensive; that is, the bulk of the system's life-time cost is for the equipment, not a fuel. The need for large up-front investment can make the systems appear less economically attractive in the short term than a fuel-burning system, but their inherent security and environmental advantages will lead to increased use in the decades to come. Increased reliance on domestically available resources will improve both energy security and economic productivity.

Renewable energy technologies currently make important, often under-recognized, contributions to the Nation's energy supply mix. Renewable energy is about 9% of national energy supplies. This contribution can be

expected to reach about 12% of domestic energy production over the next two decades as industry continues to deploy currently competitive technology and begins to exploit the commercial opportunity of technology just now emerging from the R&D process. Similar trends are observed within the international marketplace where renewable energy is playing an increasing role in both industrialized and developing economies.

Today's research will lay a foundation for an even larger role for renewables in the Nation's longer term energy supply system. Renewable energy technologies appear poised to make vital contributions to electric power generation, industrial process heat requirements, solid, liquid, and gaseous fuel needs, and the cooling, lighting, and heating of buildings. Advances in electric energy systems and in energy storage will provide the basis for greatly improved utilization of renewable resources. The DOE research program undertakes research in each of these technology areas.

In order to realize their large potential contribution to the Nation's energy supply, renewable technologies will have to be competitive in the energy market and be compatible with the existing supply system. The Department of Energy's Renewable Energy Program is working toward the goal of producing a technology base upon which the private sector can build to provide the economy with a broader selection of competitive energy supplies. The Federal R&D program serves as a catalyst to stimulate private sector development of renewable technologies.

The current strategy of renewable energy programs is to concentrate Federal resources on scientific and engineering research to achieve a better understanding of the characteristics of renewable energy sources, of the technologies for collecting and converting these sources to useful forms, and of the generic materials sciences to support industrial development of reliable and efficient systems. DOE's research emphasizes basic and applied research and exploratory development that supply the scientific and technical basis for increasing cost-effective use of the renewable energy resource base and important crosscutting technologies for storage of energy and for reliable and efficient management of the electric energy supply network. The focus of such efforts is on those technologies with the greatest long-term promise for contribution to the Nation's energy supply mix. The goal is to advance the technology while avoiding interference with the capacity and responsibility of industry to develop specific commercial products and services.

The Renewable Energy Research Program is structured to ensure maximum responsiveness to the technical innovation requirements of the private sector. Private sector input regarding research direction and emphasis is sought through integration of industry experts in the review and planning of research activities, direct participation of private sector organizations and universities in the Renewable Energy Research Program, and maintenance of an open and active dialogue with industry, trade associations, and universities. Renewable energy technologies can be significantly advanced through research. Many R&D successes have occurred to date, with between two- and ten-fold improvements in technology cost, efficiency, and reliability. Many important scientific and technical obstacles in resource assessment, materials, and

systems integration remain, but we are confident that they have been identified and that a sustained research commitment will provide solutions.

A brief review of the funding request for each technology describes the research activities that will advance renewable energy toward its enormous long term potential.

SOLAR BUILDINGS

Recent research has shown that significant increases in the supply of useful solar energy to buildings can be obtained from developments in electrochemistry, holography, optical physics, and advanced materials. For example, switchable glazings, commonly referred to as "smart windows", and advanced phase change thermal storage wallboard materials could double the present solar energy contribution to building heating energy requirements. The FY 1989 Solar Buildings Program budget request of $5.4 million will continue progress in establishing the essential technology base required for industrial development of promising new materials, systems, and related solar building technologies. The goal of the Solar Buildings research program is to increase the energy contribution of solar technologies to the point where 70% to 80% of the total requirement for space heating, hot water, cooling, and lighting of many different types of buildings could be supplied at costs that are competitive with conventional fuels.

The FY 1989 program in solar building materials and components includes continued research on new optical and thermal switching films which control solar gains and thermal losses through building apertures. The switchable

film technology has made significant progress towards development of multi-layer electrochromic film assemblies with demonstrated ability to switch reversibly over 100,000 cycles. Work will continue on optimization of the individual film materials. For solar cooling, desiccant materials research has led to prototype dehumidifier systems with substantially improved performance, using microbead silica gels. Several organic materials show promise of dramatic increases in moisture absorptivity and will be experimentally evaluated.

Systems integration research will continue to evaluate the most appropriate systems for applying solar heating, cooling, and daylighting systems in residential and non-residential buildings. An important element of the FY 1989 systems integration research program will be development of analytical tools to enable architects, engineers, and homebuilders to predict the performance of solar building systems using advanced materials. Analysis techniques will be developed for integrating solar technologies with conventional heating and cooling systems. Researchers will also analyze and evaluate the performance and reliability of various solar building technologies when integrated in buildings.

PHOTOVOLTAIC ENERGY

Over the past year, photovoltaics (PV) has continued its steady progress toward emerging as a competitive energy supply alternative. The program has produced increased conversion efficiencies and reliability and reduced costs,

all of which have helped U.S. industry establish a leadership position in the competitive world photovoltaics power market, with a broad range of energy products.

In FY 1989 the Photovoltaics Program, with an updated five year research plan and with a budget request of $23.38 million for operating expenses and $0.8 million for capital expenses, will continue the advances resulting from the first research plan covering 1983-1988.

An important step in realizing the potential of photovoltaics as a viable source of energy is the assessment of field performance of installed systems together with maintenance and other requirements. Recognizing this need, the DOE has maintained a seven year program of regular monitoring of experimental systems operating in the field. A recent report on this assessment effort arrives at several significant conclusions. First, the overall consistency of energy production from these systems suggest that performance degradation over time has been minimal; many of the problems in earlier systems have been overcome. Secondly, photovoltaic performance is well understood and can be accurately modeled, thus effectively assuring the quality of new systems designs. Thirdly, to date the typical failure rate of single crystal photovoltaic modules averages well below .5 of 1% per year; efforts are underway to translate these results to today's potentially low cost thin film modules. Finally, and importantly, the current operation and maintenance (O&M) costs for large photovoltaic plants is 0.5 cents per kilowatt hour which compares favorably with current O&M for coal and nuclear. The present conventional single crystal silicon modules are, however, costly and thus

emphasis must be placed on advanced materials to obtain higher performance and lower costs and to maintain these attractive reliability and operating results with the new generation PV materials.

U.S. research leads the world in addressing the issues leading to more effective thin films which offer manufacturing cost savings over their single crystal counterparts. In the past year, devices of three different thin film materials have been made with efficiencies greater than 11%, representing the current world record for thin films. Coupled with the higher efficiencies is the development of new, potentially low-cost deposition processes to produce thin films in even larger areas. Thin-film transparent conducting oxides, a product of our research, may also find their way into automobile glass manufacturing. Car windows using this spinoff technology will thus be capable of more rapid and complete defogging and deicing than previously believed possible.

We have also sponsored research that has stretched the boundaries of very high efficiency materials for use in concentrating solar collectors. These materials, with efficiencies of 24%, should lead to the development of multi-layered designs called multijunction cells that are capable of collecting more of the sun's spectrum and can potentially attain greater than 30% sunlight-to-energy conversion efficiency.

From our long-term commitment to fundamental research at thirty leading U.S. universities, we have improved our understanding of photo-degradation, developed new materials to replace expensive or highly toxic precursors used

in various PV device processes, and developed new processing steps that, when introduced in production lines, will lead to more cost effective photovoltaic energy devices. Based on our research plans, three photovoltaic options could be positioned for industry consideration of production scale-up by the early nineties. These options include various new advanced forms of crystalline silicon, thin films of amorphous silicon or other compounds, and high efficiency materials such as gallium arsenide compounds for use in concentrators.

The success of the photovoltaic program would not be possible without the close collaboration between the U.S. industry and the DOE. We have worked as partners, sometimes under 50/50 cost sharing arrangements, in the steady advancement of this important technology. The FY 1989 program will maintain and build on this partnership to investigate multijunction concepts, large area submodules of thin films, and concentrator concepts and the high efficiency devices that they require. Research will also address the issues of large area scaleability and throughput. Underlying this work will be the fundamental investigations at universities in new electronic materials, low band gap alloys, mechanisms that limit cell performance, and crystal growth. The program will also maintain the unique capability at SERI for precise measurement of material and cell parameters and reliability testing and research. This important technology base research guides researchers throughout the U.S. in understanding and correlating observed physical phenomena. Finally, the wealth of information gathered by the program,

together with the special capability available through the Sandia Design Assistance Center, will be used to assist the U.S. photovoltaic industry to build industry leadership domestically and internationally.

SOLAR THERMAL ENERGY

The DOE Solar Thermal Technology Program conducts research on concentrating solar energy systems to meet future electric power and process heat energy needs. The program recognizes not only the importance of advanced research, but also the need for intermediate, high-value technology of more immediate interest to the solar thermal industry. These potential opportunities are in thermal and electric applications, including products for export, hazardous waste destruction, water reclamation, cogeneration, and the production of transportable fuels and high value chemicals.

The DOE Solar Thermal Technology Program is structured both to conduct research on innovative concepts and also to develop reliable, low cost, high performance solar components and systems. Program activities are responsive to user and industry needs.

The results of past solar thermal R&D have supported industry in bringing to the marketplace systems that utilize centrally located engines and first - generation concentrating collectors. Examples of such systems are the Solar Total Energy Project in Georgia, the five LUZ SEGS plants, and the LaJet SOLARPLANT 1. If all existing SEGS utility contracts are fulfilled, it would bring their installed capacity to over 550 MWe and over three and half billion dollars of private investment.

However, because of the projected reduction in electricity capacity additions and low conventional energy prices, it is clear that solar thermal energy utilization will not increase significantly without future reductions in its cost. Thus research is continuing on components that cost less and have improved performance, reliability, and efficiency. The specific objective of proposed research activities is to drive the projected energy cost down from the present 12¢/kWhe to 5-7¢/kWhe for electric power production and to $9/MBtu for process heat applications. Achievement of this capability would make energy from Solar Thermal Technology competitive with many other energy supply options.

The Solar Thermal budget request of $14.7 million operating expenses and $0.3 million capital expenses for FY 1989 supports those activities which address the critical technical uncertainties and performance and cost improvements necessary to achieve the energy cost goals. Those activities include the continued development of innovative membrane heliostats and dish concentrators that have shown dramatic reductions in weight, material requirements, and cost. Research will also be continued on an advanced falling film direct absorption receiver and a sodium reflux receiver that has the potential to significantly improve the efficiency and lower the costs of central receiver and parabolic dish systems. Cost-shared projects with industry to develop highly reliable, mass-producible engines for dish applications will also be pursued. Research on new applications such as solar-enhanced chemical processing and toxic waste destruction will also be continued.

BIOFUELS

Biofuels energy research focusses on the production of liquid fuels, such as alcohols, gasoline, and diesel fuel, and gaseous fuels such as biogas and thermgas. These fuels can be produced from almost any plant material and from certain waste products such as municipal waste. These raw materials, or feedstocks, can be converted into fuels by thermochemical or biochemical processes, or can be combusted to produce steam, heat, or electricity.

Biofuels currently supply 2.8 quads, or approximately 4% of U.S. energy needs, primarily from the combustion of wood. Although this amount of energy is noteworthy, current applications do not exploit the major potential of this unique resource: its ability to produce liquid and gaseous fuels, the energy products this Nation needs most.

The Biofuels and Municipal Waste Technology Program focusses research on selected pathways for biofuel production which are most promising and whose combined realizable energy potential is about 17 quads, or about 20% of current U.S. energy consumption. To achieve this potential, the program addresses fuel pathways that use new or currently available feedstocks for conversion to (1) alcohol fuels, (2) biocrude-derived gasoline, (3) plant oil derived diesel fuel, (4) biogas, and (5) thermgas. These fuel pathways have been incorporated into the program's plan which was developed with input from academia and industry. The renewable liquid and gaseous fuels produced by these pathways provide alternatives to conventional petroleum, natural gas, and other fossil fuels. The FY 1989 budget for Biofuels Energy Systems is $10.48 million operating expenses and $.555 million capital expenses.

Certain aspects of terrestrial crops production research such as increased growth, environmental requirements, and monoculture viability requirements are applicable to all fuel pathways while other research selects and tailors specific feedstock characteristics such as lignin, moisture, and ash content to fit specific fuel pathways. The terrestrial crops technologies include short-rotation intensive culture (SRIC) and herbaceous energy crops (HEC). SRIC research will focus on developing Populus as the lead wood energy candidate. Industry cost-shared monoculture viability projects will continue. HEC research concentrates on selection of species and techniques for conversion to liquid and gaseous fuels. Techniques for development include genetic and biotechnological methods to increase productivity, stress and disease resistance, and energy traits tailored to the specific fuel cycles. HEC research will continue screening species in the Great Plains, Midwest, and Southeast.

Part of the plant oil research focusses on rapeseed, which directly produces plant oil. Laboratory research will use biotechnology to improve the characteristics of the oil as a diesel fuel source. The field research will complete the trials of rapeseed as a winter crop in the Southeast.

The second element of the plant oil fuel pathway, aquatic energy crops research, continues to concentrate on increasing the growth and lipid content of microalgae. Physiological and lipid characterizations of specific strains will be completed and the best performing strains will be selected for advanced productivity and lipid enhancement research. In addition, an outdoor

test facility will be operated to evaluate the productivity of selected laboratory developed strains.

Thermochemical conversion research focuses on two fuel pathways; biocrude gasoline and thermgas production from biomass and wastes. The biocrude gasoline research continues to concentrate on producing biocrude oil from woody feedstocks and on upgrading and refining biocrude oils to gasoline. Thermgas research includes steady-state experiments converting high moisture feedstocks to methane gas and continued development of fundamental data such as thermgas clean-up and compression requirements for methyl alcohol production. Research will continue to develop the fundamental data and equations that are essential for the conversion of municipal solid waste to liquid and gaseous fuels. This research includes data for heat transfer and product formation at different pyrolytic conditions. Laboratory research and field tests to develop powdered Refuse Derived Fuels (pRDF) as a direct substitute for oil in existing boilers will continue.

Biochemical conversion research is also focused on two fuel pathways: ethyl alcohol fuels and biogas. The ethyl alcohol fuels research focuses on enzymatic hydrolysis of lignocellulosic feedstocks. Research will be conducted to improve pretreatment methods and evaluate and test advanced enzyme production systems. The biogas research continues to focus on improving anaerobic digestion reaction rates, increasing gas yields, and establishing reactor stability and control. In addition, research efforts will continue using genetic techniques to develop improved anaerobic microorganisms.

In FY 1989, capital equipment funds will be used to maintain the R&D momentum by providing the research centers with state of the art equipment capabilities. Specific equipment requirements include instruments to measure soil, light, and growth conditions, reaction rates, and yields.

WIND ENERGY

The year 1987 saw continued expansion of wind turbine use in the U.S., with an estimated 160 megawatts of capacity added, bringing the installed base to 1460 megawatts. The average size of wind turbines increased in 1987, to slightly over 100 kW. While the rate of capacity growth has slowed since 1985 and fewer commercial firms now exist, a number of the stronger manufacturers and developers are continuing research and development and are beginning to explore overseas markets. Most importantly, the performance and operational availability of machines in the field has continued to improve. Wind turbines in California produced over 1.8 billion KWh of electricity during 1987, which is enough power for 300,000 homes. In addition, the Mod 5B project has been successfully completed. During the 3 month acceptance test period it achieved 106 percent of design performance and an operational availability of 94.7 percent. This is a major achievement during the initial tests of a new and advanced technology machine. In January 1988, the Mod 5B was turned over to the host utility as part of a cooperative agreement to begin utility operational testing and routine power generation.

The objectives of the Department's Wind Energy Program are to improve the understanding of the fundamental physics of wind turbines and to translate

this understanding into tools that industry can use to design and develop more reliable, efficient, and cost-competitive wind turbines. The FY 1989 request for Wind Energy is $8.3 million for operating expenses and $0.5 million for capital equipment. These funds will support research in two broad areas: (1) the basic science of wind turbine dynamics that includes atmospheric fluid dynamics, aerodynamics, and structural dynamics, and (2) advanced components and supporting research, in which improved airfoils, variable speed operation, wind/diesel controls, acoustic noise generation and propagation, and systems analysis are studied.

In the area of wind turbine dynamics, FY 1989 efforts will be continued to increase understanding of turbulence, which is a major issue for performance and design loads, and the effects of terrain on general patterns of wind flow and turbulence that strongly affect energy production and structural stresses, particularly in wind farms. Cooperative research and field testing with industry, using existing turbines in commercial windfarms where possible, have proven to be cost effective. Additional testing is planned to ascertain why some turbines have unaccountably experienced extensive structural damage in the windfarm environment. Research evaluations will include wind tunnel and field studies to observe key elements of unsteady flow and performance validation of existing models through cooperative research. A major commitment to structural dynamics experiments is proposed to correlate the wind input to machine stresses through single and multiple instrumentation tower arrays close to an operating turbine. Several blade material fatigue projects will be continued in concert with industry and results will be employed in an experiment involving the combined experience of the national

laboratories and industry to provide an extensive data set for subsequent structural analysis.

In the advanced components area, field testing will be continued on improved airfoils for horizontal and vertical axis turbines. This is an area with considerable retrofit potential for existing turbines and has immediate practical applications for industry. Airfoil development efforts will be continued, guided by results from the basic sciences area. Field testing of variable speed control systems through cooperative research is anticipated and research will also be continued to better understand the design and operation of wind/diesel systems.

OCEAN ENERGY

The Ocean Program conducts research and development on ocean thermal energy conversion (OTEC) technology to enable the private sector to make informed assessments of the potential of this technology as a significant energy supply alternative. This is accomplished principally through research on components and systems modelling. The long-range goal of the OTEC program is to achieve sufficient advancement in technology to result in a projected capital cost of $3200/kWe (1984 dollars). The program strategy focuses on reducing the technical uncertainties which would be associated with 5-15 MWe, near-shore, island-based systems, which are judged to be appropriate for the most likely initial OTEC markets. The FY 1989 budget request is $3.1 million for operating expenses.

The installation of a seawater supply system was recently completed at the Natural Energy Laboratory of Hawaii. Cosponsored by DOE and the State of Hawaii, this system draws cold, nutrient rich water from a 2,100-foot depth and supplies both the planned DOE-supported OTEC open cycle 165 kWe experiment and Hawaii-supported mariculture activities. The 40-inch pipe is the largest diameter pipe deployed on the steepest slope known to date.

In FY 1989, the program will concentrate on three areas of research: experimental verification and testing; thermodynamic research and analysis; and materials and structures research. The objective of the experimental verification and testing program is to verify functional feasibility, performance, and operational characteristics of OTEC components, such as heat exchangers and process controls, on a scale that can be extrapolated by industry in designing small plants. During FY 1989, DOE will continue conducting a set of open cycle OTEC component heat and mass transfer experiments leading to integrated tests at the 165kWe level which is considered to be the point from which extrapolations can be made. The installed DOE and State of Hawaii sponsored cold water pipe will be instrumented to determine its response to the ocean environment.

One objective of the thermodynamic research and analysis program is to experimentally determine the effects of trapped gas bubbles and seawater on the open-cycle conversion process. Work will be continued on specifying the performance requirements and initial configuration of the low pressure power converter to be employed in the 165 kW open cycle tests. The program will also experimentally validate selected power system analytical models at a

scale sufficient to extrapolate the data beyond the laboratory level. Confidence in these models is important if industry is to design open and hybrid cycle power systems that meet the cost goals of the program. Achievement of these goals is dependent upon increasing the output of the power system and reducing the projected life cycle costs of major components. Materials and structures Research will emphasize the acquisition of data on fouling, corrosion, and erosion of open cycle turbine and heat exchanger materials. This work will be conducted in the ocean environment at the Natural Energy Laboratory of Hawaii.

OTHER SOLAR ACTIVITIES

Support activities for the planned research programs includes international, technology transfer, and resource assessment programs, the function and maintenance of the Solar Energy Research Institute, and program support and direction. The FY 1989 budget request for these activities totals $12.85 million.

An integral part of the renewable energy programs is technology transfer activities, for which we are requesting $1.78 million in FY 1989. Through a variety of activities, such as publications, professional seminars, industry workshops, and the Conservation and Renewable Energy Information and Referral Service, the program disseminates critical information about renewable energy to researchers, industry, and the general public.

The Federal Government is playing a major role in promoting U.S. renewable energy technology in the highly competitive international marketplace through

programs sponsored by the interagency Committee on Renewable Energy Commerce and Trade (CORECT). The FY 1989 request for international activities of $.541 million will be used to continue the technical assessment, educational, and industry assistance services of CORECT.

We are requesting $.970 million in FY 1989 for program support activities which provide cross-technology analytical and administrative support to the overall renewable energy research effort. The main objective of the coming year's planning and analysis efforts will be the implementation of multi-year technology development strategies, which will help guide future research activities and enhance their effectiveness.

A reliable solar radiation resource data base is essential to electric supply planners and industrial engineers for designing, siting, and managing efficient, reliable solar power systems. It is equally vital to researchers who require increasingly specific resource data to pursue resolution of the complex scientific issues associated with the solar processes being addressed within the technology research and development programs. We are therefore requesting $.754 million for FY 1989 to continue resource assessment activities that will improve the accuracy of the National Data Base, to obtain reliable current resource measurements to be added to the data base for selected U.S. locations, and to improve the understanding of the temporal resource variability and spectral characteristics.

The Solar Energy Research Institute (SERI) is the primary national laboratory carrying out solar research and development. The $4.64 million request for FY 1989 includes $4.0 million to conduct the final design and initiate construction of the SERI Phase II facility. The 100,000 square foot building will include laboratories with vibration-free floors and toxic materials handling and ventilation capabilities for performing needed solar materials research. The existing laboratory space is housed in leased office buildings that cannot accommodate the program's experimental needs and involve material handling and safety concerns. The $.640 million balance of the request is for improvements to the experimental apparatus (General Plant Equipment) and facilities (General Purpose Projects).

The FY 1989 request of $4.164 million for Program Direction will support staff activities in project management, R&D coordination, technology transfer, and program and general administration duties.

GEOTHERMAL ENERGY

The Geothermal Energy Program carries out research and development, in cooperation with industry, on an array of geothermal resource types (including hydrothermal, geopressured, hot dry rock, and magma) and on energy conversion technologies designed to define the technical and economic boundaries of this vast domestic energy resource. Program activities include applied research, technology development, and technology transfer efforts that will provide the basis for the timely introduction, by the private sector, of new concepts and

products into the marketplace. The funding request for FY 1989 for the Geothermal Program is $15.6 million for operating expenses and $0.8 million for capital equipment.

Hydrothermal research will expand the accessible resource base by improving the processes for extraction and injection of geothermal fluids, developing new materials capable of withstanding high temperatures and pressures and corrosive environments, continuing brine chemistry research leading to techniques to prevent plugging of wells and pipes, and developing advanced power cycle technologies to increase power generation efficiencies. Researchers will analyze and synthesize data derived from the very high temperature geothermal reservoir at the Salton Sea Scientific Drilling Project, and data pertaining to the young volcanic area of the Pacific Northwest. In addition, newly developed tracers and interpretation methods will be field tested with industry at Dixie Valley, Nevada, and East Mesa, California. Research will also be carried out on a cost-shared basis under the Geothermal Technology Organization (GTO) with emphasis on high-priority research where results are thought to be attainable in the near term.

The geopressured research program is proceeding to define the technical characteristics and recoverability of the large reservoirs of hot brine and dissolved methane that lie beneath the U.S. Gulf Coast. The FY 1989 program includes experimental well flow testing, tests of the conversion of the brine energy content (thermal and chemical) to electricity in cooperation with industry, and supporting research on the dynamic response of geopressured reservoirs to production conditions. The geopressured research program

continues to set records for the cumulative volume of geopressured brine produced and has proven the long-term effectiveness of downhole scale inhibitors.

Hot dry rock research involves the evaluation of the properties of deep crystalline rock and the development of methods to extract geothermal heat from such resources. A new seismic technique for locating fracture planes in crystalline rock was recently developed. Surface equipment will be installed in FY 1989 for the long-term flow test of the large fractured reservoir at Fenton Hill, New Mexico. This will mark the last major milestone in determining the feasibility of current heat extraction methods.

The purpose of the magma energy research program is to develop the technology to locate magma chambers and to extract energy from them. FY 89 research efforts are aimed at determining the depth and size of a large continental magma chamber, evaluate alternative methods of energy conversion, and develop alloys, well cements, and instrumentation capable of performing in the 800 to 1000 degree Celsius magma environment. In FY 1989, the observation well at the Long Valley caldera in California will be drilled.

Hard rock penetration research will improve the technology and reduce the uncertainty of geothermal well drilling, which currently represents about half of the cost of geothermal power. Geothermal wells exceed the cost of typical petroleum wells by factors of two to four, due to the fact that geothermal wells are generally deeper and encounter harder rock, higher temperatures, and more corrosive fluids than do oil and gas wells. Experimental program efforts

include research on wellbore diagnostics technology, improved systems for drilling, instruments for detecting fractures in rock formations, and drilling fluid loss control. Tests and experiments will also be carried out on a cost-shared basis under the Geothermal Drilling Organization (GDO).

GEOTHERMAL RESOURCES DEVELOPMENT FUND

The Geothermal Resources Development Fund was established to guaranty private lenders against losses on loans made for the development and use of geothermal energy. Its broader purpose is to develop normal borrower-lender relationships that will provide financing of geothermal projects without Federal risk-sharing. The FY 1989 request is $.075 million in operating expenses which allows for monitoring outstanding loans.

HYDROPOWER

Small-scale hydropower technology is nearing maturity and the DOE program has made significant contributions to the technology base. Therefore, no funds are requested for FY 1989. Ongoing contracted analytical and technical support will be phased out utilizing prior year contracted activities. The remaining technology development and R&D projects then will be monitored by DOE personnel funded within the Geothermal Program Direction request to ensure that technical goals and contractual and reporting requirements are met.

ENERGY STORAGE AND DISTRIBUTION

An increasing reliance upon a broad array of technology-based energy systems will require the development of advanced energy storage and distribution

technologies to provide reliable interfaces with the Nation's existing energy distribution infrastructure.

ELECTRIC ENERGY SYSTEMS

Research in the Electric Energy Systems (EES) Program is designed to provide a technology base to enable the future electric energy network to operate more reliably and more economically while protecting health and safety and the Nation's security. The FY 1989 budget for the Electric Energy Systems research is $17.8 million. The request includes some $12.7 million to begin to translate recent superconducting material advances into technology appropriate to power generation and distribution.

The new high temperature superconducting materials have great potential for application on power systems, including generators, motors, transformers, storage, and control and protective devices. Greater system efficiencies, improved system stability, and reduced cost are all possible if the material can be improved to meet the needs for these devices. Presently the material has too low a current density, is too brittle, and is chemically unstable. However, this program is directed at solving these very difficult challenges, and laboratory, industry and academia teams are being formed to make and keep the U.S. competetive worldwide. This research will build on the fundamental knowledge base developed over the past decade, within the electric energy systems program with the previous generation of metallic (helium temperature) superconductors.

Areas of investigation will continue to include determination of the biological health effects due to exposure to high voltage electric and magnetic fields; development of methods and options to ensure appropriate system reliability and the efficient use of resources during expansion of the Nation's future electric networks; development of techniques to provide electric power over a wide range of system conditions including both normal and emergency situations as well as improvements needed for national security; and development of new materials, advanced controls, and new design concepts to improve the efficiency of electric systems, including high temperature superconductivity. The EES program continues to support research in three program areas: Electric Fields Effects, Reliability R&D, and System Concepts.

In FY 1989 the Electric Field Effects research will continue to determine the impact of combined electric and magnetic fields on living tissue, whole bodies, and abnormal cell growth. Results of research in this area have been transferred through public forums and technical papers and are the basis of important international research. Research results to date include human studies which indicate only temporal whole body impact.

The Reliability R&D activities will continue research on assessment of the high energy impact of an Electromagnetic Pulse (EMP) on the Nation's electric power systems operations and continuing studies on control and operating strategies to mitigate the effects of an EMP. Assessment and modeling of real power systems are virtually complete. Important verification of these models still remain. Methods and strategies to operate complex, very large

integrated electric power systems through improved system stability, operational, and restoration techniques (on-line detection and recognition research) will be completed.

Systems Concepts research will continue on conducting polymers for power system applications. Research will be expanded in the high-temperature superconductivity area, developing concepts and practical conductors for application of future devices on electric systems. This research builds on the past low temperature (helium) research of the Electric Energy Systems and Distribution Program as well as the fundamental research conducted by DOE's Office of Energy Research. The research effort will involve research teams from the national laboratories, the private sector, and academia working together on specific issues so that research results can be transferred to the commercial marketplace at the earliest possible time.

ENERGY STORAGE

The Energy Storage program conducts research to provide a technology base to develop advanced storage technologies. The FY 1989 budget for the Energy Storage research is $8.466 million in operating expenses, with $.027 in capital equipment. This request includes $0.75 million for superconducting magnetic storage.

The program has moved toward a more basic and fundamental research agenda which will continue efforts on advanced energy storage systems to improve the efficiency of energy use and enhance the Nation's renewable energy resources. The program will permit international cooperation, thereby providing informa-

tion exchange on the latest technology developments of advanced energy storage systems world-wide. The energy storage program ranges from fundamental research, to exploratory development of technical concepts, and includes work on new concepts, materials, and components. The variety of technologies includes batteries, fuel cells, and thermal storage. This research provides an alternative for supplying future energy needs extending the useful life of existing utility central generating equipment for increasing the economic attractiveness of renewable energy generating sources and addressing needs for alternate transportation options. As renewable sources of energy become even more competitive, and the penetration into the energy networks increases, the need for energy storage for these intermittent sources becomes more important. These technologies will be used in residential, commercial, industrial, transportation, and utility installations to promote more cost-effective energy use.

In FY 1989 the Electrochemical Storage research activities will continue toward determining the structure, composition, and mode of formation of surface layers on solid and porous electrodes; understanding electrolyte transport; developing new electrochemical couples; and analysis and design of battery and fuel cell components. This will be accomplished with new analytical tools and the study of the relationship between the kinetics of electrode processes and the atomic structure of the electrode surfaces. Other electrochemical research activities will include improving the reliability of the electrolyte for the advanced batteries; continuing performance tests of sodium/sulfur cells designed for electric vehicle applications; and evaluating and developing new sodium/sulfur, zinc/bromine cell designs for electric

vehicle and load leveling applications which have improved durability and reliability. Also, research will be initiated to devise innovative concepts for superconducting magnetic energy storage to determine feasibility of smaller capacity, lower cost devices. Electrochemical progress in the past year has included greatly improved solid electrolyte materials, new membranes for fuel cells, and advancement in air electrodes, all of which will contribute to higher levels of reliability and reduced costs.

Thermal and Chemical Storage research will focus on improving the technical and economic viability of seasonal thermal energy storage for commercial and industrial application. Research on hydrogen will continue with higher efficiency electrolysis process improvement.

CONCLUSION

The programs presented for your review today show enormous potential for the future. Collectively, their potential applications are expected to ultimately make them highly attractive candidates for private sector development and deployment. These technologies promise increasing competition within the energy marketplace.

The programs represent a solid commitment to the continuing development of these technologies. We are confident that our proposals will increase understanding of the potential for virtually all of the most promising renewable energy options and conservation technologies and will substantially contribute to the base of technical information required for informed decision making by industry and consumers. This is a budget which I believe seriously

recognizes today's fiscal responsibilities, as well as tomorrow's anticipated needs.

Thank you for the opportunity to present our budget request.

Attachment

CONSERVATION SUCCESSES

I would like to mention some of the major accomplishments achieved during Fiscal 1987 in the Conservation program. We are pleased to be able to identify certain accomplishments that can contribute to manufacturing productivity and enhance the international competitiveness of our domestic industries.

In the Multi-Sector program, the race for commercial exploitation of the first truly ductile ordered intermetallic alloy, nickel aluminide, for high temperature applications took a step forward with the recent announcement by Oak Ridge National Laboratory that it has licensed the technology to Armco Inc., one of the largest steelmakers in the United States. The unusual property of this alloy is increasing strength at higher temperatures, rather than declining strength as in conventional alloys.

The Energy-Related Inventions Program provided assistance to an inventor who designed a new packing ring to reduce leakage in steam turbines. The ring is designed to provide a tighter seal during operations and improve overall turbine efficiency by one percent: electric utilities could save up to $200 million annually in generating costs by using this new packing ring.

In the Industrial Programs, in cooperation with the private sector, a number of new processes have been developed. In cooperation with Construction Technology Labs/Portlant Cement Association, a more energy-efficient grinding process which increases cement particle breakage efficiencies has been developed. The greater control of particle sizes results in direct and indirect energy savings of up to 30% over conventional cement production and utilization practices.

A Brayton cycle heat pump, designed to recover volatile organic solvents from waste vapors, was developed and installed at a 3M magnetic tape production facility in Minnesota. The unit has just started operation and is expected to save 38 billion Btu/year with an estimated value of $500,000. A second unit, of a different configuration based on the same design, has been installed by 3M in another plant.

In another area, significant progress has been made in developing a new technology called Impulse Drying. Designed for paper machine use, it works by bringing wet paper into contact with a very hot metal roll, typically at 400 to 700 degrees F, while maintaining high pressure on the sheet. Laboratory tests have shown that between 200 and 1000 Btus are required to remove each pound of water from liner board. This compares with the 1600 to 1800 Btus per pound required using conventional cylinder drying. It is projected that, when commercialized, impulse drying will save 0.2 quad of energy annually, or a tenth of the total used by the paper industry.

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In the Buildings and Community Systems program, construction of the DOE Roof Research Center at the Oak Ridge National Laboratory has been completed. The Large Scale Climate Simulator is undergoing calibration and will be ready for full research capability in 1988. The unique capabilities of the center are expected to improve energy efficient roofing design, address problems faced by the roofing industry, and help the roofing industry move toward modern technology and new materials.

A new technology that has significant potential in replacing chlorofluoro-carbon refrigerants in refrigeration applications has been developed. An experimental breadboard apparatus utilizing large counterflow heat exchangers and a nonazeotropic refrigerant mixture produced energy efficiency improvements of 32 percent. These improvements were measured under a typical cooling operation of a heat pump.

The National Bureau of Standards, with support from the Buildings and Community Systems program, has completed the Calibrated Hot Box facility which has been used to develop a recommended ASTM test procedure for the dynamic thermal testing of walls. This will facilitate the prediction of actual performance of advanced complex wall systems and will help establish a strong technology base in an area where there is strong Japanese and European competition.

In the Transportation program, the formal inauguration of the High Temperature Materials Laboratory as a User Center occurred in December 1987 with the first meeting of the User Advisory Committee. The Committee has been organized to review user proposals for nonproprietary research and consists of two representatives from industry, one from the university community, one from DOE, and two from the Oak Ridge National Laboratory. We hope that this facility will help keep American industry at the lead in this critical area.

An inexpensive device for the management of combustible gases emitted from aqueous batteries has been developed by Johnson Controls under contract to DOE. The device prevents the battery case from rupturing in the event of an ignition of the gases within the cell during charging or operation of an electric vehicle. The device was successfully demonstrated in nickel-iron battery modules during recent tests. The device is scheduled for incorporation in the final Eaton dual-shaft electric propulsion system van battery packs. This device improves the safety characterictics of electric vehicles.

Senator FOWLER. Well, thank you, Madam Secretary, again for your statement and its brevity, but also the complete program that you have submitted for the record. And we will certainly welcome the opportunity to review those multiyear plans as you just asked us to do.

Let me ask you just a couple of questions. When you make the proposition I see here in the statement of cutting 17 percent for solar and 45 percent for conservation, how do you go about that? What criteria do you use in reaching those figures?

Miss FITZPATRICK. Mr. Chairman, we don't really approach the budget process with a goal to make a cut. We start from the bottom up and we try to build the priorities of what is the most important thing that we can do in each technology area.

Frankly, we don't choose our budget numbers either, as you well know. We are given a target figure to work within. We have had some success in appealing and getting some additional funds, but we are very much I guess like the appropriations committees. We get a number and we're told to do what we can within it. It's not that we set out to cut from current appropriations; we set out to do the very best we can with what is available to us.

Senator FOWLER. But you have tremendous leeway within. If you're going to go into conservation, you've appeared before us many times giving credit to conservation, the success of our conservation program.

Miss FITZPATRICK. Yes.

Senator FOWLER. And yet, one of the largest, if not the largest, cut is in an area of conservation, 45 percent, where the administration has over and over again bragged of its effectiveness and its accomplishments. How do you justify that?

Miss FITZPATRICK. You justify it by saying if we have a particular goal to achieve—that is, for example, to design a new automobile engine that has certain efficiency specifications, has an alternative fuel possibility, flexible fuel possibility, has a certain cost, certain weight, certain power specifications. Then we set out to say how much will it cost us to do that, and we work out the research plan, try to figure out how long it will take, who will have to be involved and how much it will cost. So, actually, aside from having the kinds of limits that are applied to every Federal program, our budgets are built with a goal in mind. We are trying to get to a goal which is what we have determined as best we can is what the country needs to improve its energy efficiency or reduce its petroleum consumption.

We have programs in every area that take that approach. For example, we are confident that it is technologically possible to reduce the energy consumption of fluorescent lighting. Lighting use is a very large part of the electricity consumed in the United States. And we have identified certain technological improvements that could be made in fluorescent lighting systems and then we lay out a program to how can you achieve those, how do we test them, and price it out, and that goes into the budget. So, it's very much a specific, concrete goal-oriented budget process.

Senator FOWLER. Well, I think whether we agree or disagree that there is substantial irony in the fact that the one area where success has been documented and where you have agreement across

the board that the savings have been great and achieved at the smallest cost, conservation, comes in this year as almost the largest item for cutting in the budget.

I could think of a stronger word than irony. In an administration that prides itself on its cost effectiveness—and your budgeting from the ground up is not new. The last President called it the zero based budgeting, starting at the bottom and relooking at everything. But somewhere, it seems to me, it is pretty obvious that we didn't see the forest for the trees.

Miss FITZPATRICK. I would be the first to admit, Mr. Chairman, that number one, increased efficiency saved us more energy and is saving us more energy each year than we are getting in the form of new supplies from conventional sources. That's very true.

Senator FOWLER. And with the potential for continuing a conservation effort.

Miss FITZPATRICK. That's true.

Senator FOWLER. The potential is unlimited for saving those future supplies.

Miss FITZPATRICK. Not unlimited, but very large. Let's say we are saving 16 quads a year now over what we would have been using if we had continued the use trends of the early 1970s, and that is about correct, 16 quads a year. Using presently available technology, what you could buy today, if we fully implemented that technology, we could save another 16 quads. And I'm not even talking about doing more R&D and using the fruits of that. I'm talking about presently available technology.

The reason that technology isn't being implemented fully has a number of sources. One is that people don't want to replace capital equipment that has a long lifetime of maybe 20 or 30 years until they have fully depreciated what they already have. Another reason is that we tend to do things in Federal policy that discourage people from making the investments that they need to make. We have a tax system that encourages short-term outlook. We have taken away or will take away very soon the investment tax credit. Capital preference is gone. The accelerated cost recovery system is gone. What people are looking for——

Senator FOWLER. Almost all of those advocated and pushed by the administration.

Miss FITZPATRICK. That's true in return for other trade-offs. But what I'm saying is I think that we have to——

Senator FOWLER. It wasn't in return for anything.

Miss FITZPATRICK. Pardon me?

Senator FOWLER. I say it wasn't in return for anything.

Miss FITZPATRICK. Well, they thought it was in return for lower tax rates. But a lot of people pushed that. I mean, that went through.

And I think we ought to consider what effect it has in the area of adopting new technologies not only for energy efficiency but for overall economic productivity. There are a lot of people who are pointing this out that we have too much of a short-term outlook. And I think that is true.

Senator FOWLER. I don't think there is any question about that.

In your budget you asked for $4 million, just to pick out one little item here, for a new building for the Solar Energy Research

Institute, but we see the House Appropriations Committee took it out.

Miss FITZPATRICK. Yes.

Senator FOWLER. Are you going to fight for that money?

Miss FITZPATRICK. Yes, sir.

Senator FOWLER. What about the extra $24 million that the House increased in the solar R&D money yesterday or the day before yesterday? What are you going to do with that money?

Miss FITZPATRICK. I haven't had a chance to read that carefully. I understand that it is fairly broad; that is, they simply added some for photovoltaic, some for wind, I think some for biomass. And if that is the case, we would work down our priority list and use it—that is, I don't think the House specified below those kinds of descriptions what it should be used for. And if that is the case and it's appropriated, we would simply work down our priority list.

Senator FOWLER. What is on your priority list?

Miss FITZPATRICK. We would work in photovoltaics, for example, in advanced materials, that is, finding new combinations of——

Senator FOWLER. No. I'm not just talking about solar now.

Miss FITZPATRICK. Okay.

Senator FOWLER. What is on your hot priority list if all of a sudden we give you some money——

Miss FITZPATRICK. Across the board?

Senator FOWLER [continuing]. That you don't want.

Miss FITZPATRICK. Obviously, the great area of our vulnerability in energy is not so much a lack of energy. There's lots of energy. It's our dependence on petroleum. And we use most of our petroleum for highway fuel, for diesel and gasoline for cars and trucks. Therefore, a big target for opportunity and one that we are working on is to devise more efficient engines, to devise engines which can use alternatives to petroleum based fuels, such as alcohols, and to have commercially competitive electric vehicles. And one of the priority areas we should work on is to improve those technologies, and that is where I would put additional funding—better electric vehicle motors and control systems, better batteries, in particular better batteries. That is going to be the key to electric vehicles.

In the buildings area, we need work on advanced refrigeration systems and heat pumps. We have a special problem now in that the CFCs, which have been very effective as refrigerants, working fluids, coolants and in the manufacture of insulation, are probably going to be limited in their availability in the future. And, therefore, we need substitutes for chlorofluorocarbons, either direct substitutes or systems that don't require those kinds of materials. So, I would work in those areas.

In the industrial area, we need more in waste heat recovery, in topping cycles for cogeneration systems, in waste heat recuperators and heat pumps, as well as some key industrial processes where we have very high energy intensity industries such as basic metals and pulp and paper. And we are working closely with those industries to try to improve their processes.

Those are generally the kinds of targets I would look for.

Senator FOWLER. Welcome, Senator Wirth from Colorado. Senator, do you have any questions you would like to ask at this time?

Senator WIRTH. I do, indeed. Thank you, Mr. Chairman.

Secretary Fitzpatrick, what percentage of the international commitment to solar energy is now reflected by what we're doing and how has that changed over the last eight years? Do you know?

Miss FITZPATRICK. I don't have in my head a figure, and I can try to develop some for you, Senator, of how much of total international work in solar R&D. I want to make sure I understand that question. What percentage of that is coming from the U.S.

Senator WIRTH. Yes.

Miss FITZPATRICK. I will develop some figures for you.

[The information follows:]

INTERNATIONAL SOLAR R&D

The attached available data reflect 1987 solar research and development expenditures by International Energy Agency countries.

1987 IEA GOVERNMENT SOLAR ENERGY RD&D EXPENDITURES
(Millions of U.S. Dollars)

Country	Solar Heating & Cooling	Photo-voltaics	Solar Thermal	Wind	Oceans	Biomass
Australia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Austria	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Belgium	1.95	0.91	n.a.	0.52	n.a.	0.93
Canada	2.71	1.28	n.a.	2.00	0.30	7.69
Denmark	n.a.	n.a.	n.a.	8.00	n.a.	0.76
Germany	5.67	31.00	30.00	12.9	n.a.	0.94
Greece	1.93	2.34	n.a.	2.04	n.a.	n.a.
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Italy	4.82	30.00	0.46	13.00	n.a.	8.23
Japan	3.44	49.00	0.82	2.70	1.01	10.64
Netherlands	1.28	4.10	3.26	23.60	0.99	4.34
New Zealand	0.03	n.a.	n.a.	0.01	n.a.	0.06
Norway	n.a.	n.a.	n.a.	0.40	0.68	1.08
Portugal	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	1.61	6	4.00	0.90	n.a.	6.37
Sweden	5.66	0.55	0.08	5.40	0.16	6.15
Switzerland	5.37	1.68	1.01	0.33	n.a.	2.07
Turkey	0.16	0.07	0.03	0.06	n.a.	0.05
United Kingdom	1.96	0.16	n.a.	9.50	1.80	2.29
United States *	6.5	41.4	23.30	16.70	4.50	24.50

Notes: "n.a." = data not available

Source = Draft IEA Reports "IEA/SLT(88)13" and "IEA/CRD(88)14"

* The United States data are for FY 1986.

Miss FITZPATRICK. The trends have been generally that our budget has been going down in real terms, and the budgets of some countries in some targeted areas have been increasing. However, in other areas those same countries have been reducing their budgets. So, I'm not sure that looking at what foreign countries are doing that there is a clear trend in one direction or another. Some countries are definitely increasing some of their work.

Senator WIRTH. What are the Japanese, for example, doing in photovoltaics?

Miss FITZPATRICK. They have apparently increased.

Senator WIRTH. What are we doing in photovoltaics?

Miss FITZPATRICK. We have reduced our work there.

Senator WIRTH. Why are they increasing and we're decreasing?

Miss FITZPATRICK. I think they are playing catch-up.

Senator WIRTH. They're playing catch-up.

Miss FITZPATRICK. Yes.

I think also they are very aggressive about it. They see a market and they want to get it.

Senator WIRTH. And we don't think there is a market there.

Miss FITZPATRICK. Pardon me?

Senator WIRTH. We've decided there isn't a market there.

Miss FITZPATRICK. Oh, no. What we have done is to target the power system market, not the consumer product market, the wrist watch/pocket calculator kind of a market, which is where the Japanese have been dominant. That's a very low tech photovoltaic cell that they use in that. They turn it out by the millions, and that market has basically stabilized. That is not a growing market.

The growing market, the future for photovoltaics, is in true power systems, electricity supply to run things. And that is a growing market now and it is economically competitive for remote applications. And the United States has the lion's share of that market and it has the best technology and the best products available and the fastest evolution of new products.

Senator WIRTH. And what is happening to our budget in that area?

Miss FITZPATRICK. What we are doing, in coordination with industry—and a great deal of our work is cost-shared with industry—is they have to help us to identify the particular technological problems that they think they need to resolve in order to improve their product efficiency and, most of all, to bring the cost down and to increase the lifetimes and reliability of those products. So, we have a very targeted cost-shared research program.

Senator WIRTH. That is a pretty promising area.

Miss FITZPATRICK. Yes, it is.

Senator WIRTH. Overall in the Department of Energy, what are the priorities being placed on budget expenditures looking at an eight-year trend in that area versus what we're doing in nuclear?

Miss FITZPATRICK. I'm not familiar with the long——

Senator WIRTH. Hasn't the solar budget, for the most part, gone down consistently and the nuclear budget has gone up?

Miss FITZPATRICK. The figures that I've seen that actually compare research on technologies—those budgets are fairly close together.

Senator WIRTH. But our overall commitment to also turning that technology into—that research into development programs has gone down in solar, hasn't it?

Miss FITZPATRICK. Yes, it has.

Senator WIRTH. And it's gone up a lot in nuclear, isn't that right?

Miss FITZPATRICK. No. For actual R&D on new technologies in nuclear, my understanding is and the figures I've seen are that it has gone down. It has gone down rather dramatically.

Senator WIRTH. How would you compare the trend lines in solar versus coal?

Miss FITZPATRICK. Well, if you include clean coal technology, there is no comparison.

Senator WIRTH. How is that? Solar is that much better than clean coal technology?

Miss FITZPATRICK. No. There's a $5 billion program, $2.5 billion Federal, $2.5 billion private, over five years to address clean coal technology.

Senator WIRTH. Does that mean that you all think that clean coal is that much more promising than solar?

Miss FITZPATRICK. Well, I have to say that that is a product not of the Department of Energy so much, but that's a foreign——

Senator WIRTH. What was the President's request in that area?

Miss FITZPATRICK. Pardon me?

Senator WIRTH. What was the President's request in that area?

Miss FITZPATRICK. In clean coal? It's the $2.5 billion over five years.

Senator WIRTH. I don't understand that. I mean, that has gone up, you said, significantly, and solar has gone down. So, why aren't you all supporting that coal technology? I mean, if that is what the President requested, why do you seem to be reluctant in supporting that?

Miss FITZPATRICK. No. I'm not saying I'm reluctant to support it. I'm saying that the drivers behind that were more than—were an energy security consideration. I'm not saying that it isn't justified. There are very serious environmental concerns. There are foreign policy concerns behind that. It's not simply an energy——

Senator WIRTH. Then why was it done?

Miss FITZPATRICK. I wasn't—you know——

Senator WIRTH. No, but I mean, you all are up here defending this budget——

Miss FITZPATRICK. Yes.

Senator WIRTH [continuing]. Which has dramatic cuts in the budget in front of us. And yet, this other you're saying has an increase of $2 billion.

Miss FITZPATRICK. It was done, I'm sure, because we have a very large supply of coal in this country. It is a major part of our domestic energy resource.

Senator WIRTH. We have a large supply of solar too, don't we?

Miss FITZPATRICK. That's true.

Senator WIRTH. There's a lot of sun, right?

Miss FITZPATRICK. We are already producing about 55 percent of our electricity from coal. We have serious concerns both within the United States and in our neighbors that using that coal is causing environmental problems. And it was resolved that those problems should be addressed.

Senator WIRTH. Whose concerns are those——

Miss FITZPATRICK. The Canadians.

Senator WIRTH [continuing]. About the environmental problems?

Miss FITZPATRICK. The Canadians, New England, the midwest.

Senator WIRTH. Has the administration expressed a concern yet about that coal and what it might be doing in the environment?

Miss FITZPATRICK. As far as I know, there are still many questions, but at least the administration said they wanted to address——

Senator WIRTH. You're a good soldier.

Miss FITZPATRICK. I'm a good soldier.

Senator WIRTH. Secretary Fitzpatrick, you're a good soldier. [Laughter.]

It is a pretty sad record, isn't it?

Tell me what you all are doing in the area of global warming. As we look at the energy research and development budget, what are you all doing in the area of global warming?

Miss FITZPATRICK. We have done some studies—and I believe we're working closely with the EPA, for example—to assess what is happening, especially with the CO^2 effects and methane effects in the atmosphere. It's a matter of concern. We would like to find out as much as we can about what might happen in the future if we continue current trends of combustion of fossil fuels, what are the opportunities to reduce the combustion of fossil fuels, and assuming reasonable reduction in fossil fuel use, what can we expect to be the effect on CO^2 in the atmosphere and the global warming trend. And I believe that there is budget money in the Office of Energy Research for pursuing some of that work.

Senator WIRTH. One would say, if in fact you are concerned about long-term reduction of the use of fossil fuels, and if that is a major contributor to global warming, and if one assumes that the evidence is in—and I know that there are those who would like to study it until we all boil to death—but if those are the cases, then it's a bit difficult to understand as an observer on the outside why one then declines, takes down, reduces research in solar, which runs counter to that commitment, increases research and money being spent on coal, which runs counter to that commitment, reduces a commitment to auto efficiency, which runs counter to that commitment. And it all seems to me to be mutually exclusive. It just doesn't make any sense to me. I'll give you a final shot here and you can make the record. How does all of that add up? Tell me how do you reconcile all of those disparate positions at the Department of Energy in the administration.

Miss FITZPATRICK. Or the Congress.

Senator WIRTH. I'm sure you're at the vortex of a vast number of interest groups that are coming in rapping on your door, but fill me in on how this works.

Miss FITZPATRICK. Well, I'm sure my position is no worse than that of any Member of Congress because you get the same sorts of things.

I think what happens is that we have a short-term view, as I mentioned earlier. There is no doubt that we have an immediate dependency on fossil fuels which is not going to go away simply because of the huge capital investment that would have to be made in order shift ourselves substantially and very rapidly off of our present energy production systems and onto something else, even if that something else were technically satisfactory right now and available. Therefore, we have an immediate problem to solve, and it's my understanding that that is what the clean coal technology program is attempting to do.

In the long term, I fully agree with you that we should recognize, number one, that many of the fossil fuels, particularly oil, are in finite supply and, in fact, if we continue to use them at our present rate with the known reserves, identified reserves, in the world, we can see within current lifetimes that they would begin to run out. Therefore, we have to plan for the day when we will not be able to run our transportation systems, for example, basically on petroleum fuels.

So, I agree with you that we should continue the development of alternative technologies. When they are ready technically, then we should begin to use them in whatever economically efficient or justifiable way there is. Now, it isn't just economic efficiency. What is really driving right now the use of alternatives to petroleum fuels is not really economics and it isn't even energy security; it's environmental considerations. And I think that those also have to come into play. We may be willing to pay a premium for non-petroleum automotive fuel for environmental considerations, not for energy security considerations. And that's fine. That means you get more bang for your buck. You get two benefits.

Senator WIRTH. Well, Donna, as I've said before, you're a good soldier. I've always thought your analysis was good. Unfortunately, the program given to you doesn't meet the analysis. Right?

Miss FITZPATRICK. We're working on it.

Senator WIRTH. And there's not much else that we can all say about that at this point.

Let me ask you if you can supply to us—could you give us a quick analysis as to what is being done now in terms of global warming?

Miss FITZPATRICK. Yes, I will.

[The information follows:]

GLOBAL WARMING ANALYSIS

Attached for the record is an analysis of how much has been spent on global warming from FY 1978 to FY 1988 by institutions and by work areas. There have been a number of analytical studies by DOE laboratories over the past several years on global warming. Attached are reports on these research efforts. *

*The reports submitted have been retained in committee files.

Carbon Dioxide Budget History - Work Breakdown Structure
Carbon Dioxide Research Division, Office of Energy Research, DOE
(1,000 dollars)

Work Breakdown	FY78-82	FY1983	FY1984	FY1985	FY1986	FY1987	FY1988	TOTAL	Percent of Program Funding (all fiscal years)	FY1989
Energy Systems	16915	3389	3565	3435	3037	3105	3300	36746	35	
Climate Systems	7244	1936	3525	4272	4030	4448	4630	30085	29	
Agro-Ecosystems	2966	1444	2514	2454	2892	2970	3700	18940	18	
Resource Analysis	793	525	1441	970	639	464	500	5332	5	
Scientific Interface	1031	1082	1253	1482	1341	1032	1105	8326	8	
Integration and Evaluation	1840	580	102	429	457	565	341	4314	4	
Program Development and Management	1359	0	0	0	0	0	0	1359	1	
Total	32148	8956	12400	13042	12396	12584	13576	105102	100	17600
Budget Adjustment	-35	10	73	30	35	460	210	573		
Total Budget		8966	12473	13072	12431	13044	13786	105675		

Carbon Dioxide Budget History - Type of Institution
Carbon Dioxide Research Division, Office of Energy Research, DOE
(1,000 dollars)

Type of Institution	FY78-82	FY1983	FY1984	FY1985	FY1986	FY1987	FY1988	TOTAL	Percent of Program Funding (all fiscal years)	FY1989
University	15548	2950	4250	5648	5330	5020	5416	44162	42	
Laboratory	11170	4205	5901	5334	4708	5458	5888	42664	41	
Government	2935	1078	1286	778	1053	738	796	8664	8	
Industry	410	510	536	686	845	829	894	4710	4	
Other Interface	2085	213	427	596	460	539	581	4901	5	
Total	32148	8956	12400	13042	12396	12584	13576	105102	100	17600
Budget Adjustment	-35	10	73	30	35	460	210	573		
Total Budget	32113	8966	12473	13072	12431	13044	13786	105675		

Senator WIRTH. Solar numbers. I mean, you know what those are and I know what those are. But how long would it take to do that?

Miss FITZPATRICK. I believe we have some materials not in our office, but at another office in the Department I will put together for you as quickly as possible.

Senator WIRTH. Could we get those by first thing next week? Would that be possible to do that?

Miss FITZPATRICK. I will try, yes.

Senator WIRTH. That would be great. Thank you very much. Nice to have you here, and again I appreciate the ambiguities of the job you have to do. [Laughter.]

Thank you, Mr. Chairman.

Miss FITZPATRICK. If it's worth anything, Senator, I can point out that our requests this year are up from last year, for what that's worth.

Senator WIRTH. For whatever it's worth, I'd ask you to compare this year versus 1980.

Miss FITZPATRICK. Yes.

Senator WIRTH. It's pretty devastating, isn't it?

Miss FITZPATRICK. Right. For almost anybody's budget.

Senator FOWLER. Senator Evans will inquire.

Senator EVANS. Thank you.

I suspect you will know what I am likely to ask about. But you did say I think very wisely—we ought to say it more often and more loudly—that we better start now getting a pretty good idea of what we are going to utilize for transportation energy in this world. It may come to that requirement a lot sooner than we think.

What in your view are the best potentials?

Miss FITZPATRICK. Senator, the Department is now in the process of doing a study on alternative transportation fuels. We have put out the preliminary report which lays out our assumptions and our methods and what we are trying to accomplish. We expect to have the study completed by the end of this year. It will address the use of alcohol fuels, both ethanol and methanol, compressed natural gas and electric vehicles as alternatives to petroleum.

Senator EVANS. Only those?

Miss FITZPATRICK. Only those four for the study—that's true—because those are the ones that are now ready or very nearly ready to go. What we are looking for is alternatives that we could begin to implement to the extent that they would have a substantial impact before the end of the century. So, we are looking at presently available or very nearly available technologies.

We are going to assess the cost of implementing those; that is, how much would it cost to build the production, distribution and utilization facilities for those technologies, what kind of environmental impact would they have, how much petroleum use could we back out, what would be the effect on our energy security, questions of that nature. I'd be happy to send you the first report which lays out the purpose of the study and what our assumptions are. And you will, of course, receive the later parts as they are prepared.

[The information follows:]

ALTERNATIVE FUEL REPORT

The Department is conducting a study entitled "Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector." The first progress report in the study, "Context and Analytical Framework", is attached.* The remaining sections will be published during 1988 and will be supplied to the Committee as they become available.

Senator EVANS. Well, it would be helpful to get that. Assumptions in a study drive the results.

In this one will there be a full assessment of the current total economic price of petroleum fuels? I sometimes think that we don't take into full account the—you know, there are comparative economics. And if, on the one hand, we're going to talk about new fuels and say we need to know the price of the distribution system and all of these other elements that go into the total cost of that fuel, how effectively in your view are we measuring the current cost of environmental degradation and the corrections that we are engaged in to try to clean them up directly from petroleum fuels? I don't know to what extent you can take that. If you believe that it's having an effect on ozone production and an effect on warming and all of these other effects, how in the world do you ever translate that into a current economic cost of our present fuel?

Miss FITZPATRICK. That is clearly a very difficult question. That is one of the issues that we will attempt to address. The study is on the costs and the benefits of using alternatives to petroleum. And, therefore, it seems that every alternative has both costs and benefits.

Senator EVANS. Sure.

Miss FITZPATRICK. And we would try to assess those against our current practices.

Senator EVANS. But that's what I'm concerned about. If we assess them against current practices, I hope that we will analyze the total costs of current practices—

Miss FITZPATRICK. Yes.

Senator EVANS [continuing]. So we really get the full economics into it. And I'm rather certain that we haven't done that in the past, not we being the Department or anything else, but I mean just generally as a society we've ignored some of those costs.

Miss FITZPATRICK. I think your point is very well taken, and I will find out if we're going to do an assessment of the use of petroleum itself and what it is costing us and see if that can be included at this point. But I think your point is quite correct.

Senator EVANS. You know my interest in the potential of hydrogen as an alternative fuel. I noticed in your testimony toward the end you did talk about the efforts to increase the efficiency of the electrolysis process. Are you also looking at the—I'm not even sure there is a potential, but sort of the direct connection of photovoltaics utilizing the solar energy to translate directly into what then can be electrolysis itself and the economics of that? Well, maybe that's what you are talking about here. I don't know.

Miss FITZPATRICK. We are looking at the improved hydrogen production techniques. Our goal in photovoltaics is to make it economically competitive with other choices for generating electricity.

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* The portion submitted has been retained in committee files.

And, therefore, if we find that electrolysis techniques for generating hydrogen are economic and attractive, then photovoltaics, if it were also comparable to other sources of electricity, could certainly play a part in such a system.

Senator EVANS. But I would guess that here again if you take total cost into consideration, the direct costs of creating the electrical energy necessary for electrolysis by, say, photovoltaics and by a fixed, central plant fueled by coal, it might be equivalent if you just had direct costs. But then do you add in fully the costs of acid rain, the costs of all of the other problems environmentally that may come from the production of electricity in some other fashion?

Miss FITZPATRICK. We have taken a preliminary look at that kind of thing: what are the environmental costs and effects, land use, risk to life, that kind of thing, of say a coal plant versus a similar capacity photovoltaic plant. And you have to manufacture the steel and the glass to make the photovoltaics.

Senator EVANS. Yes.

Miss FITZPATRICK. You have to have the land area.

Senator EVANS. I know it's a difficult process.

Miss FITZPATRICK. It's a very painstaking sort of a process. And I'm happy to say I think photovoltaics comes out way ahead.

But our problem right now is that the benefits to achieve that—that is, the environmental benefits that we might enjoy from photovoltaics are still being outweighed by the actual capital cost of a photovoltaic system. It is still too expensive, but those costs are coming down steadily. And we think that we have identified what as to be done to reduce them.

Senator EVANS. But if the costs are coming down steadily and if we got to the point where that was really a focus—it's not just photovoltaics for electrical use in a lot of other ways, but the potential that that could open up broad new opportunities on the transportation fuel side—why then are we down in two years by about 40 percent in the amount of money we're asking for photovoltaics?

Miss FITZPATRICK. Partly because we have overall budget limitations. And I've never claimed that we couldn't spend more money than we were requesting and spend it very productively. I've never tried to make that argument. We are trying to fit within budget limitations that are imposed on us.

Senator FOWLER. There's also a large export potential for photovoltaic, is there not?

Miss FITZPATRICK. Yes, there is. And that is the market that I was discussing with Senator Wirth that the remote power systems market is growing, and we have a very strong position in that and we intend to maintain that position.

I'm sorry. I lost my train of thought.

Senator FOWLER. I lost it for you.

Senator EVANS. It's that reduction. Well, the three biggest areas within this general field are photovoltaics, solar, thermal and biofuels. There is about a similar reduction in each of them. Is that to say that they are sort of equal priority? Have priorities changed at all in the last two years, or do we just assume in budget cuts everybody takes their share?

Miss FITZPATRICK. To some extent, everybody takes a hit.

Senator EVANS. But it seems to me that when you get down to real budget constraints, rather than everybody taking their hit so nobody can do a job, wouldn't it be better to really focus on what appears to be the most promising and the most important and try to focus your efforts there?

Miss FITZPATRICK. Well actually, Senator, about three years ago we did an analysis of the potential for various renewable energy resources available in the United States to supply our energy needs. I think we called it an energy contribution potential. And it was done by source and by region, since some regions of the country have one resource and others have another, and it was also done by the kind of energy that would be produced, be it fuel, liquid, gaseous or solid, or direct heat or electricity. Then once we knew which were the big potential contributors to our energy needs, then we went through and looked for the technological advances that we would have to achieve in order to realize those potentials. And then we looked to see what was the strength of the industry in each area, which ones would need more or less Federal help. And it's that analysis that has really formed the basis of our deriving our budget over the last several years. That's how we identify our priorities.

So, to answer your question, it isn't just that we say we have this big a pie and we're going to give an equal slice to everyone. We don't give an equal slice to everyone. We try to meet, as much as we can, at approximately equal levels of productivity—research productivity I suppose you could call it—to move each one of those technologies closer to being able to achieve the energy contribution potential that they have.

Senator EVANS. And I think that's an appropriate way to do it.

If we were to add more to the $80 million than the fiscal year 1989 request—just assume for a moment that it went back to $96.8 million that was in the fiscal year 1988 appropriation—if we add another $16 million, would you go back to essentially all of those figures that were in the 1988 appropriation, or would you have somewhat different priorities in where you would add money?

Miss FITZPATRICK. There are some items in the appropriation which have come to their natural conclusion. We do actually finish some research projects occasionally. There are other items which we had not recommended, and in some cases the industry itself had not recommended to begin with, and we would not do those. But we do have what we think would be very productive work that could be done.

Senator EVANS. Could you submit to the committee for its perusal where you think just in these general categories another $20 million would be best spent, where the priorities would be if you had that?

Miss FITZPATRICK. Yes, Senator, I will.

[The information follows:]

SOLAR R&D PRIORITIES

The following table reflects the next $20 million of priorities for Solar Energy Research and Development which is predicated on funding for the baseline research contained in the President's FY 1989 budget request.

SOLAR ENERGY R&D PROGRAM PRIORITIES

The following is a priority list of the next $20 million of Solar Energy Research and Development activities and is predicated on contents which were included in the President's FY 1989 budget request.

Priority	Program	Funding ($ millions)	Subprogram
1	Solar Energy	$ .7	Biofuels - Terrestrial Crops - Capital Equipment
2	Solar Energy	1.4	Photovoltaics - Fundamental Materials Research
3	Solar Energy	.9	Biofuels - Biochemical Conversion - Thermochemical Conversion
4	Solar Energy	1.4	Photovoltaic - Capital Equipment - High Efficiency Materials - Advanced Thin Films
5	Solar Energy	1.0	Wind - Atmospheric Fluid Dynamics Research
6	Solar Energy	5.2	Photovoltaics - High Efficiency Materials, Fundamental Research -
7	Solar Energy	.3	Research Solar Buildings - Daylighting
8	Solar Energy	.7	SERI - GPP/GPE
9	Solar Energy	.6	Solar Thermal - Collection Technology Research - Distributed Receiver
10	Solar Energy	1.7	Wind - Advanced Components Research - Supporting Research
11	Solar Energy	.1	Solar Resource Assessment
12	Solar Energy	.6	Photovoltaics - Fundamental Materials Research
13	Solar Energy	.5	Solar Buildings - Solar Systems Integration - Solar Cooling and Dehumidification Research

Priority	Program	Funding ($ millions)	Subprogram
14	Solar Energy	2.0	Solar Thermal - Energy Conversion Technology - Central Receiver System Technology - Collective Technology Research
15	Solar Energy	1.2	Solar Program Direction
16	Solar Energy	.7	Solar Technology Transfer -
17	Solar Energy	.2	Solar Program Support
18	Solar Energy	.8	SERI - GPP
Total		$20.0	

Senator EVANS. One final question. Are you aware of a recent news article on the flight of an experimental Soviet plane fueled by hydrogen?

Miss FITZPATRICK. No. I had not seen that, Senator. I would be interested to.

Senator EVANS. I'll see if we can find the citation and find out what is going on with it.

Miss FITZPATRICK. Thank you.

Senator EVANS. Thank you, Mr. Chairman.

Senator FOWLER. Staff has asked me, Madam Secretary, to remind you, if you could, to submit these requests as quickly as possible because appropriations will be marking up in about two weeks.

Miss FITZPATRICK. Yes, Mr. Chairman, I will.

Senator FOWLER. While we're on it, I can't let you go without a personal plug here of my own bill, S. 1554, with which I'm sure you're intimately familiar. It was written just with every presidential guideline and hope and aspiration in mind, joint development and research, overwhelming public purpose, global input in its impact. And it has a companion in the House, whose number is H.R. 4226. This sets up joint research and development ventures with private firms in photovoltaics, factory-made housing and others, including addressing the problem we discussed on photovoltaics in rural areas and third world countries.

We have some general comments, but it would be very helpful to me if your staff could give me a line-by-line analysis—it's a short bill—as quickly as possible. My Chairman is very interested in this bill, and we would like to pass it this year with the enthusiastic support of the Department of Energy.

Miss FITZPATRICK. We'll try to do that, Mr. Chairman.

[The information follows:]

COMMENTS ON BILL S1554

Section 2: Indicates the reasons for Congress to pass the bill and establishes the bill's purposes.

Comment: We agree that renewable energy and energy conservation technologies can help to diversify our country's energy sources and make them more secure. We believe, however, that the present method of setting goals, arriving at annual appropriations, and administering the research programs for these technologies and the current content of the programs have been successful. Funding for these programs has remained relatively stable over the last several years, and the United States continues to be the world leader in the general field of renewable energy technologies. In addition, demonstration programs tend to be costly and freeze technology at its current level, rather than resulting in greater innovation. We cannot agree that it is "also appropriate for the Federal Government to support near-term demonstrations so that United States firms will have not only technology but also products to market." We believe that the development of products is absolutely the responsibility of private sector firms themselves. For these and the more detailed reasons that follow, we are strongly opposed to this bill as drafted.

Section 4(a): Establishes general and specific goals for the Wind, Photovoltaic, and Solar Thermal Programs and defines program content.

Comment: The Department of Energy has hired and retained a scientific and engineering staff to manage each of the current renewable programs, including the 3 areas mentioned above. Each of these individuals has expertise or experience in the technical area he or she is assigned to manage. Several are recognized nationally. All of these individuals participate in the preparation of plans, including both long range multi-year plans and annual operating plans. As part of the planning process, goals and objectives are established and the major elements of program content are determined from among numerous options. Significant inputs are provided by field organizations who have contributed to, or have frontline contact with, the most recent technical advances. Draft multi-year plans are circulated to industrial and academic reviewers who are invited to comment on the goals, objectives, content, schedule, and Federal role. These plans usually incorporate quantitative goals for system costs, efficiencies, installed base, and similar parameters. Adjustments are made to the plans as appropriate. The final product is based upon input from the Nation's foremost authorities in each area and reflects viewpoints of government, industry, and academia.

By substituting specific legislated targets for informed decisionmaking, the proposed Bill would circumvent this valuable ongoing planning process. It would reduce program managers'

flexibility, limit the ability to react to new developments, and rigidize the direction research paths can follow.

Section 4(b): Establishes 3 year authorization levels for 7 renewable energy program areas.

Comment: Multi-year authorizations can be a useful approach for certain Federal programs where the Administration and Congress generally agree on the thrust and funding levels. Where there is lack of agreement, however, such action pre-empts the opportunity for either side to present data or supporting information during the annual budget process. Since the proposed authorization levels are substantially higher than recent administration requests, we cannot support this Section.

Section 4(c): Requires a proof-of-concept or near-commercial demonstration projects for wind, photovoltaics, and solar thermal technologies; requires a report on the analysis of options available to the Secretary to accelerate commercialization of the 7 renewables.

Comment: The requirement for demonstrations and for commercialization analysis appears to be dependent on a series of presumptions that may not be well-founded. For example, the assumptions that there exists a meritorious and scientifically appropriate demonstration or proof-of-concept activity in each of the 3 technology areas named, or that industry would react favorably to government involvement in the commercialization process, or that the public would be well served by fostering the entry of more expensive energy technologies into the U.S. energy system, in our view, are not valid.

In addition Federal demonstrations have had a poor record in advancing the progress of an R&D program. They tend to freeze technology at the point where design decisions must be made, are costly and provide a poor return on the research dollar, and create constituencies that extend their lifetime beyond the time when useful information is produced.

The Department opposes the demonstration and commercialization provisions mentioned above. Without these provisions, the requested commercialization analysis report is unnecessary. Moreover, a new report covering other areas of the Department's programs in renewable energy would be duplicative of our multi-year R&D plans and the Secretary's Annual Report to Congress. In addition, the report could prove to be counterproductive. By moving the planning process away from a peer scientific and technical review process, this provision would result in the research decisions being made upon political considerations. In providing support for research projects, the government must exercise care to minimize the advantage accruing to the performer. Such concern is a not-infrequent topic of communication from non-performers and is a major reason behind our involvement in workshops and conferences and other forms of technology transfer. The

movement of government into commercialization assistance would involve the conferring of a preferred position on each awardee that would be nearly impossible to avoid.

In our view, neither the energy industry nor the energy consuming public is well served by the items contained in Section 4(c).

Section 5 : Authorizes appropriations for FYs 88-90 for funding ongoing programmatic activities and new initiatives for energy conservation R&D for the following areas: Transportation, industrial energy, buildings and community systems, multi-sector programs and management of R&D. Requires the Secretary to recommend specific amounts to be set aside for FY 89 and 90 for new initiatives and these funds shall supplement and not supplant the funds provided for the ongoing program areas.

Comment: Please see our comments under Section 4(b).

Section 6: Requires the Secretary to establish at least one joint R&D venture in each of 7 technology areas; requires joint ventures to involve specialized private firms and investors, advisory committees, and DOE; authorizes funds for each of the ventures for FYs 89-90; requires the Secretary to publish plans for the joint ventures within 180 days after the bill is enacted.

Comment: These requirements are undesirable because they add to the bureaucracy, increase the cost of performing government sponsored R&D, expand the role of Government, and make the process inflexible. Moreover, DOE already works cooperatively with the private sector under cost-sharing agreements. There are numerous cost-sharing activities in both Conservation and Renewable Energy programs and these have been a notably successful component of our R&D effort. The Department has sufficient authority and motivation to continue these activities.

Section 7: Requires the Secretary to establish a team to analyze energy use in Federal buildings and recommend cost-effective renewable energy and energy conservation improvements in such buildings.

Comments: This section is unnecessary because the Department now administers the Federal Energy Management Program established under part 3 of title V of the National Energy Conservation Policy Act (42 U.S.C. 8251-8261) that promotes energy conservation and use of renewable energy in Federal buildings. The Department believes the concept of incentive programs to promote energy conservation in Federal buildings can be an effective means of guiding agency actions. The Federal Energy Management Program along with OMB have been studying ways to develop incentive programs that will allow facility managers to carry over unobligated balances from one year to the next without some type of appropriation language. To date no workable alternative has been discovered. We would like to work further with the Committee on this provision.

Section 8: Requires the Secretary of Energy to report on the sufficiency of CORECT activities; requires member agencies to report annually on individual CORECT activities; requires a government-industry plan; requires guidelines for application for loan programs; and requires activities to target export markets. Budget authorizations for 3 fiscal years are also provided.

Comments: The CORECT currently publishes numerous documents, one of which is an annual report on CORECT activities. This document receives wide circulation and allows the reader to become informed regarding the scope and adequacy of the committee's activities. In specifying a report by the Secretary of Energy, the Bill would require duplication.

The publications now issued by the CORECT cover activities by the committee jointly and by individual members. There are currently 13 member agencies. By requiring individual agencies to report, the Bill would require 13 additional reports that would duplicate documents now available.

To be of value, the CORECT has learned that international trade guidelines must be specific to technology and to market country or region. Generalizations simply do not help. The CORECT has published several export assistance documents that have targeted a specific area of the world and included information useful to manufacturers and their agents representing one or more technologies. More such documents are expected. The government/industry "plan" specified in the Bill is a generalized document that is not likely to be of use to U.S. industry.

The stated purpose of the loan application guidelines is to "simplify application by firms seeking export assistance." The CORECT is not aware of a problem in this regard.

The requirement for the CORECT to "target renewable energy technology markets for primary emphasis by Federal export loan programs, development programs and private sector assistance programs" amounts to a restatement of one of the CORECT's current major activities. There appears to be little reason to enact such a statement into law.

Given the lack of agreement on authorization levels, our comments on Section 4(b) apply to the 3 year authorization language.

In view of the above, we believe that Section 8 adds little of value to the Bill. It specifies duplicate reports, items of questionable merit, or gratuitous material, and bureaucratizes an ongoing activity. It appears to be an attempt to repair a process that is not broken.

Section 9: Requires annual report on progress; requires a 3 year strategic plan be submitted to Congress with each submission of the NEPP.

Comments: The Secretary's Annual Report to Congress reports on the progress being made toward program goals each year. In addition, the conservation and renewable energy multi-year program plans have been provided to Congress and include the strategic plans for these programs. The additional plans required by the Bill would add little to those already available and the time and effort spent on their preparation could be better applied to other endeavors.

Senator FOWLER. Thank you very much. Thank you, Madam Secretary for your usual excellent presentation.

Dr. Peter Blair, Manager of the Energy and Materials Program, OTA. Dr. Blair, also if you could do your best to summarize, it would be very helpful to us so we can talk to you a little bit.

STATEMENT OF DR. PETER D. BLAIR, PROGRAM MANAGER, ENERGY AND MATERIALS, OFFICE OF TECHNOLOGY ASSESSMENT

Dr. BLAIR. Thank you once again, Mr. Chairman, for the opportunity to share with your subcommittee some of the findings of OTA's past as well as ongoing work as it relates to R&D needs as well as commercial prospects for conservation and renewable energy. We certainly appreciate the committee's continuing interest in our work.

First, let me address energy conservation. In retrospect over the last decade and a half, efforts to improve energy efficiency have been the most successful components of energy policy, as you discussed earlier. In many cases, indeed, these investments have exceeded even the most optimistic forecast contributing substantially to our more or less happy outcome of no increase in total energy consumption since 1974 despite a 35 percent growth in GNP.

More than a decade later, we are still seeing the results of energy efficiency investments as they continue to accumulate. And to illustrate really how far we've come down this path, last week I attended the dedication of the National Academy's new west coast facility, the Beckman Center, where the keynote speech was given by Robert Malpus, who is the managing director of British Petroleum. And Mr. Malpus' entire speech to an audience of energy experts was a plea and, indeed, a plan for placing energy efficiency at the core of energy policy in the 1990s. I don't know about you, but at least as far as I can recall, 10 years ago hearing a speech from an oil company executive like this would have been unlikely. And I believe it is increasingly, but perhaps quietly, becoming part of our culture.

Indeed, the technical potential provided by R&D to date is really far from being realized. And in my written testimony, I show several figures illustrating the historical trends of energy efficiency and the technical potential for homes, appliances, motor vehicles and other technologies.

Nonetheless, despite this remarkable progress of R&D efforts to advance the technical potential of energy efficiency, the public policy initiatives aimed at accelerating the rate of penetration of these technologies have really only been marginally successful. Over the last decade and particularly now, while there was usually sufficient incentive to replace capital stock with more efficient technology on a life cycle cost basis, the initial capital cost was often enough of a disincentive to defer the investment until existing capital was depreciated.

This, along with the sort of complacency accompanying low and stable energy prices, puts I believe different demands on our research and development efforts. And particularly, energy efficiency opportunities are now frequently viewed by industry and others as

collateral benefits to other investments such as those aimed at improving competitiveness of U.S. products in world markets or improved environmental control. For example, the improved process controls on industry might be adopted in order to reduce labor costs, but could have dramatic energy savings as well.

From a public policy perspective, the dependence of the U.S. economy on foreign energy sources still remains the Nation's most critical long-term energy problem. Indeed, the ability that we developed over the past decade to deal with short-term disruptions via the strategic petroleum reserve, increased oil production from non-OPEC sources, the dual fuel capabilities in industry, all of these steps will not affect the long-term trend toward dramatically increased U.S. oil imports which are expected to be above 60 percent in the 1990s.

Moreover, the current rate of capital turnover incorporating energy efficiency investments is not sufficient to affect appreciably our rapidly increasing dependence on imported oil. Accelerating this turnover would, indeed, require policy intervention.

In addition to energy efficiency investments, increased use of renewable resources continues to be an important component of the Nation's long-term energy strategy to ensure an energy supply at reasonable cost. Like energy efficiency, the promise of contributing to national security to reduce economic vulnerability is still a principal benefit of renewables.

In general, however, the oil price trends of the last several years coupled with the declining Federal and private support for RD&D and the changes in the tax treatment of renewable energy and conservation investments has severely diminished the sense of urgency both about renewable energy and energy efficiency and, hence, the rate of technical progress and the near-term commercial development prospects.

The eroding industry infrastructure for both research and commercial development that I reported on last year in these hearings continues. Both the number of firms and their financial viability continues to decline. For example, in many cases, only those companies holding already negotiated standard offer number 4 agreements with California utilities or perhaps the wherewithal to acquire those agreements from those who hold them, are likely to have development prospects over the next several years.

The current U.S. strategy for developing both conservation and renewable technologies assumes that there is adequate time to let private development efforts fill energy supply gaps as they appear. The strategy, however, may not be sufficiently sensitive to the concerns that originally prompted interest in these technologies. The Federal Government plays the principal role in encouraging and sponsoring timely technology development for many reasons, such as national and economic security and environmental benefit. Of particular concern I think, as the Secretary mentioned earlier, is assuring availability of substitutes for oil or improved efficiency of the use of that oil on which virtually our entire transportation system relies.

This week OTA released its assessment entitled Technology in the American Economic Transition: Choices for the Future that addresses the fundamental structural changes that have occurred in

the U.S. economy over the last decade. And this changing economic landscape has a kind of profound impact on the relative effectiveness of energy policy tools. For example, the various technology specific initiatives of the 1970s, such as the geothermal loan guarantee program or the conservation tax credits, seem somewhat strangely anachronistic when compared with general economic incentives promoting economic competitiveness in world markets that collaterally promote energy efficiency or alternative technology.

Finally, in conclusion, it seems to be an appropriate time to redouble our currently very modest efforts to mine the considerable resource of energy efficiency still possible in virtually all sectors of the economy, as well as preserve the ability to develop renewable resources. The window of opportunity of low and stable world oil prices masks any sense of urgency despite a once again rapidly growing reliance on foreign oil. The rationale for policy intervention, particularly R&D emphasis favoring efficiency, derives not only from concern over the level of oil imports, but also the national security concern over where future world oil production will be concentrated—in the Middle East—increasing concern over the environmental impact of burning fossil fuels, and the need to innovate in industry to be more competitive in world markets. Even a broad economic and fiscal policy aimed at improving U.S. economic efficiency will require continuing technical improvements and maintenance of an adequate domestic industry infrastructure as one of its components at a rate much faster than we are now delivering.

Thank you, Mr. Chairman. I'll be happy to answer questions.

[The prepared statement of Dr. Blair follows:]

TESTIMONY OF DR. PETER D. BLAIR
PROGRAM MANAGER, ENERGY AND MATERIALS
OFFICE OF TECHNOLOGY ASSESSMENT

before

Subcommittee on Energy Research and Development
Senate Committee on Energy and Natural Resources

Conservation and Renewable Energy
Research and Development

May 18, 1988

Mr. Chairman:

Thank you once again for the opportunity to share with your subcommittee some of the findings of OTA's past and on-going work as it relates to the research and development needs and commercial prospects of conservation and renewable energy technology. As you may be aware, OTA has completed a number of major assessments on the subject, including New Electric Power Technologies: Problems and Prospects for the 1990's, Industrial Energy Use, Energy From Biological Processes, and others. Currently, at the request of the House Energy and Commerce Committee, OTA is engaged in an assessment entitled Technological Risks and Opportunities for Future U.S. energy Supply and Demand that addresses this issue among many others in the context of long term energy policy. In my testimony today I address the status of research and development for both energy conservation and renewable technologies, the role of these technologies and their commercial availability in broader U.S. energy policy, and my general perception of how the Department of Energy's Fiscal Year 1989 research and

development budget request for renewable energy and energy conservation programs is responsive to that role.

THE CASE FOR ENERGY EFFICIENCY

First let me address energy conservation. In retrospect, over the last decade and a half, efforts to improve energy efficiency have been the most successful components of U.S. energy policy. In many cases, investments in energy efficiency exceeded even the most optimistic forecasts, contributing substantially to the happy outcome of no increase in total energy consumption since 1974 despite a 35 percent growth in GNP. For the most part, these investments occurred in industry, transportation, commercial buildings, and residences when fuel was a very significant operating cost, and at the same time, when the payback for such an investment could be realized quickly. In short, many actions taken were easy marks. While some of these actions were changes in patterns of energy use, such as lowering thermostats, most were investments in technology, either retrofits, such as insulating existing homes, or new investments, such as energy efficient new construction or autos with improved mileage. Indeed, more than a decade later we are still seeing the results of such investments as they continue to accumulate. While there was usually sufficient incentive to replace capital stock with more efficient technology on a life cycle cost basis, the initial capital cost was often enough of a disincentive to defer the investment until the existing capital

stock was depreciated. The public policy incentives designed to accelerate this shift to a more energy-efficient economy have been only marginally successful. Nonetheless, the trend toward increased energy efficiency continues, even in the current period of low and stable prices relative to the mid 1970's, perhaps being carried in part by the inertia of the pattern of energy efficiency investments initiated in the 1970's. However, since the rate of penetration of energy efficiency improvements has been slow, albeit steady relative to its technical potential, that technical potential is far from being realized, even with current technology. Figures 1,2, and 3 illustrate the recent historical trends in energy efficiency and technical potential for homes, appliances, and motor vehicles.

While the momentum of improving energy efficiency continues in the 1980's, the investment decision environment within which such investments are made has changed substantially from that of the 1970's. In contrast to the trends in the 1970's, the energy efficiency gains and opportunities in the 1980's, which in many cases have been just as significant as those in the 1970's, are frequently being viewed as only collateral benefits to other investments, i.e., those aimed at improving competitiveness of U.S. products in world markets. Moreover, the technology for energy efficiency continues to advance, so the opportunities for improvements in energy efficiency continue to expand in virtually all sectors of the economy. However, capitalizing on these opportunities at an accelerated rate, if such a strategy is judged to be optimal from a national perspective, may

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require policy intervention (e.g., research, performance, standards, and incentives).

Capitalizing on energy efficiency improvements viewed as a collateral benefit of other investments provides a somewhat different policy focus than the more traditional policy motivation of explicitly focussing on reducing energy imports, although the result is the same. However, the policy instruments are different. In an environment of low and stable energy prices, the motivation to innovate comes from the pressure to be competitive and hence to turn over capital more quickly in order to maintain highly productive industry. The turnover is usually not directly related to the energy efficiency improvement possible with new capital investments, but is often a natural byproduct. Hence, the kinds of energy efficiency improvements most likely to be adopted are those that provide other benefits as well. For example, improved process controls in industry might be adopted in order to reduce labor costs, but could have dramatic energy saving benefits as well.

The dependence of the U.S. economy on foreign energy sources remains the Nation's most critical long term energy problem. The ability we developed over the past decade to deal with sort-term disruptions (via the Strategic Petroleum Reserve), increased oil production form non-OPEC sources, and dual fuel capabilities in industry will not affect the long-term trend toward dramatically increased U.S. imports of oil which are expected by many analysts to be above 60 percent in the 1990's. Moreover,

while energy efficiency improvements have been remarkably successful, the current rate of capital turnover incorporating these improvements is not sufficient to affect appreciably our rapidly increasing dependence on imported oil. The current period of stability in energy supply and prices, while a welcome reprieve, cannot be used as a justification for complacency about the future. Indeed, this period provides the opportunity to advance the technical potential for energy efficiency improvements as well as develop and demonstrate technology for timely adoption.

THE ROLE OF RENEWABLE ENERGY TECHNOLOGIES[1]

Increased use of renewable resources continues to be an important component of our Nation's long term strategy to ensure continuity in energy supply at reasonable cost. Like energy efficiency, the promise of contributing to improved national security and reduced economic vulnerability by providing a diverse and virtually inexhaustible energy supply is the principal benefit of renewables. In addition, some renewables provide environmental benefits and smaller scale design features that can be better matched to energy demand and are less dependent on

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[1]For purposes of this discussion we define renewable technologies as those that do no use conventional fossil or nuclear fuels, e.g., biomass, hydropower, passive solar, solar thermal, photovoltaics, wind turbines, and geothermal. (While geothermal energy strictly speaking is not a renewable energy resource, we include in in this discussion since it has many renewable resource features and, for purposes of energy research and development, is considered part of the renewable energy technology protfolio.)

uncertain forecasts.

Some renewable technologies are already quite mature, such as hydropower, some biomass technologies, solar collectors, and passive solar design features. Others are considered to be much longer range options such as ocean thermal energy conversion, wave and tidal generators, solar power satellites, and others. Increased use of the mature commercial technologies is limited by low cost of conventional fossil fuels or availability of resources, e.g., solar heating and hydropower, respectively. Some renewable technologies, such as photovoltaics, geothermal and wind, have commercially available designs but these designs do not currently compete well with traditional technologies, with some exceptions. Moreover, as we gain experience with some renewables, we learn more about their own adverse environmental impacts, e.g., hydropower and wind. The exceptions are mostly where the technologies are deployed in the most favorable resource locations such as geothermal power in The Geysers, California or wind turbines in the Altamont Pass near San Francisco. Many of these technologies, however, have the potential for considerable improvement in cost and performance. Finally, other renewable technologies such as solar thermal power and some advanced biomass technologies (including biomass-based synthetic liquid and gaseous fuels) have very few commercial applications, but also have great potential for improved cost and performance. Many of these issues are being analyzed in OTA's ongoing assessment on the future of U.S. energy supply and demand cited earlier.

The technologies in the latter two categories (those with some commercial applications and those that are "near-commercial," waiting for escalations in fossil fuel prices and continued technical development) could be in a position for significant commercial application in the 1990's, but not at their current rate of technical development. For most renewables, the goal of research, development, and demonstration remains to reduce costs and increase performance so that these technologies can compete with more traditional energy sources. Performance improvements, cost reduction, and resolution of uncertainties will all occur, but the rate at which these improvements occur will depend on sustained progress in research, development, and demonstration, and survival of an industry infrastructure.

Table 1 summarizes the current status of selected renewable technologies along with several other alternative generating technologies and the industry that supports them. The table is a kind of summary of the testimony I provided last year in these hearings. In general, the last several years of low and relatively stable energy prices, coupled with declining federal and private support for research, development, and demonstration, and changes in the tax treatment of renewable energy and conservation investments has severely diminished the sense of urgency about energy efficiency and renewable energy, and hence the rate of technical progress and near term commercial development prospects. The eroding industry infrastructure for both research and commercial development that I reported on last year in these hearings continues. Both the number of

firms and their financial viability continues to decline. In many cases only those companies holding already negotiated Standard Offer Number 4 agreements with California utilities (or the wherewithal to acquire those agreements from those who hold them) are likely to have development prospects over the next several years.

Nonetheless, technical progress still appears to be proceeding, at least for some technologies. In particular, photovoltaics continue to be sustained by interim markets of specialized remote applications and consumer electronics. Prospects for more extensive applications in remote areas appears likely as well, which has provided the incentive for major industry sponsors, such as ARCO Solar, Solarex, and Chronar, to stay active and to continue impressive progress toward lower cost. Similarly, the success of small binary geothermal power units, on the heels of mature commercial development of vapor dominated resources at The Geysers, have kept some spirits alive for geothermal industry (e.g., in Hawaii). Other renewable technologies, however, have not fared as well. For example, the lack of interim or subsidized markets has brought solar thermal and wind technical as well as commercial development to a virtual standstill.

I noted last year that current low oil prices have brought privately financed research, development and demonstration of biomass synthetic fuels to a virtual standstill. There has been renewed interest in several biomass technologies in the last year, however, but not so much for reasons of energy supply. Instead, urban solid waste disposal problems have

prompted renewed interest in municipal solid waste power plants, although the availability of effective separation and emission control technologies is still an important concern. Similarly, local air quality concerns have provided the stimulus for renewed interest in alternative transportation fuels in some urban non-attainment areas, although the continued low cost of conventional fuels and the likely competition from coal-based synfuels remain as serious obstacles for biomass-based alternatives. Nonetheless, automobiles and trucks still comprise 65 percent of U.S. oil consumption, so promoting a diversity of alternative fuels for oil replacement remains very important.

CURRENT RESEARCH AND DEVELOPMENT POLICY CONTEXT

The current U.S. strategy for developing both conservation and renewable technologies assumes that there is adequate time to let private development efforts fill energy supply gaps as they appear. This strategy, however, may not be sufficiently sensitive to the concerns that originally prompted interest in these technologies. In particular, private industry cannot be expected to explicitly include environmental concerns or considerations of foreign policy and national security prominently in corporate investment decisions. The Federal government plays the principal role in encouraging and sponsoring technology development for such reasons. Of particular concern is assuring availability of liquid fuels as substitutes for oil or improved efficiency in the use of oil, on which

virtually our entire transportation system relies. Another concern is finding more environmentally acceptable ways to generate electricity. The current period of low and stable world oil prices, relative to the 1970's, has provided a window of opportunity for developing supply substitutes and more efficient end use technologies, to ensure commercial availability of these technologies in the 1990's.

In the early 1980's the policy tools thought most appropriate for accelerating commercial availability of alternative technologies were most often direct energy policy initiatives, such as technology-specific tax incentives, loan guaranty programs, etc. The appropriate policy initiatives may no longer necessarily be explicit energy policy initiatives alone, since, as noted earlier, the decision calculus for investing in alternative technology and energy efficiency has changed. Perhaps viewing energy alternatives and improved energy efficiency as a collateral benefit has really been the case all along and policy makers weren't sufficiently sensitive to it. Nonetheless, such a perspective ultimately affects the focus of research and development as well, since the kinds of technologies most likely to thrive in such an environment are in many cases different form those most attractive in an environment of urgency about energy. Indeed, decision makers can afford to be more discriminating and demand higher standards of new equipment, thus requiring even more emphasis on commercial demonstration of new technologies.

This week OTA released its assessment entitled Technology and the American Economic Transition: Choices for the Future that addresses the fundamental structural changes that have occurred in the U.S. economy over the last decade. The changing economic landscape has had a profound impact on the relative effectiveness of energy policy tools. For example, the technology-specific initiative of the 1970's, such as the geothermal loan guarantees or the conservation tax credits, seem strangely anachronistic when compared with more general economic incentives promoting economic competitiveness in world markets that collaterally promote energy efficiency or alternative technology.

FEDERAL ROLE IN RESEARCH, DEVELOPMENT AND DEMONSTRATION

Last year I recounted OTA's findings from several past assessments regarding the federal role in conservation and renewable energy technology development. I would like to reiterate those findings. Among the most important conditions necessary to sustain conservation and renewable energy technology development in the United States is a continued Federal presence in research, development, and demonstration (RD&D). While many of these technologies are no longer in the basic research phase, development hurdles are still formidable and the importance of RD&D remains high.

A critical milestone in commercial acceptance of these technologies is completion of a successful demonstration program. While there is

considerable debate in the energy industry over what constitutes an adequate demonstration, two basic categories are often distinguished. One is a proof-of-concept phase which provides the basic operational data for commercial designs as well as test facilities designed to prove the viability of the technology under non-laboratory conditions and to reduce cost and performance uncertainties. The other involves multiple applications of a more or less mature technology designed to stimulate commercial adoption of the technology. Generally, activities in the first category are necessary for demonstrating commercial viability and activities in the second category are necessary for accelerating commercial development. Both are necessary for significant commercial adoption.

The length of the appropriate demonstration period will vary considerably by technology. However, the nature of the demonstration program--who is participating, who is responsible for managing it, and the applicability of the program to a wide variety of operating circumstances--is of equal importance.

Generally, OTA has found that successful demonstration programs have the following characteristics:

- o The private sector should have considerable influence in the selection of technologies for demonstration as well as principal responsibility for demonstration program design and management of the demonstration project itself.

- o Private sector proprietary rights and ownership should be preserved, provided that such protection does not inhibit timely development of the technology.

- o Cost sharing between government and industry has generally proved successful in ensuring both careful selection of the most competitive projects and timely completion of the projects.

- o Federal government commitments to a demonstration program should be stable and predictable, i.e., once made, such commitments should be honored for a sufficient period in order to convince developers that government is a "reliable partner."

- o First-of-a-kind, full scale demonstration facilities should include support by all partners involved in the demonstration for not only plant engineering and construction but also for extended plant operations.

CONCLUSIONS

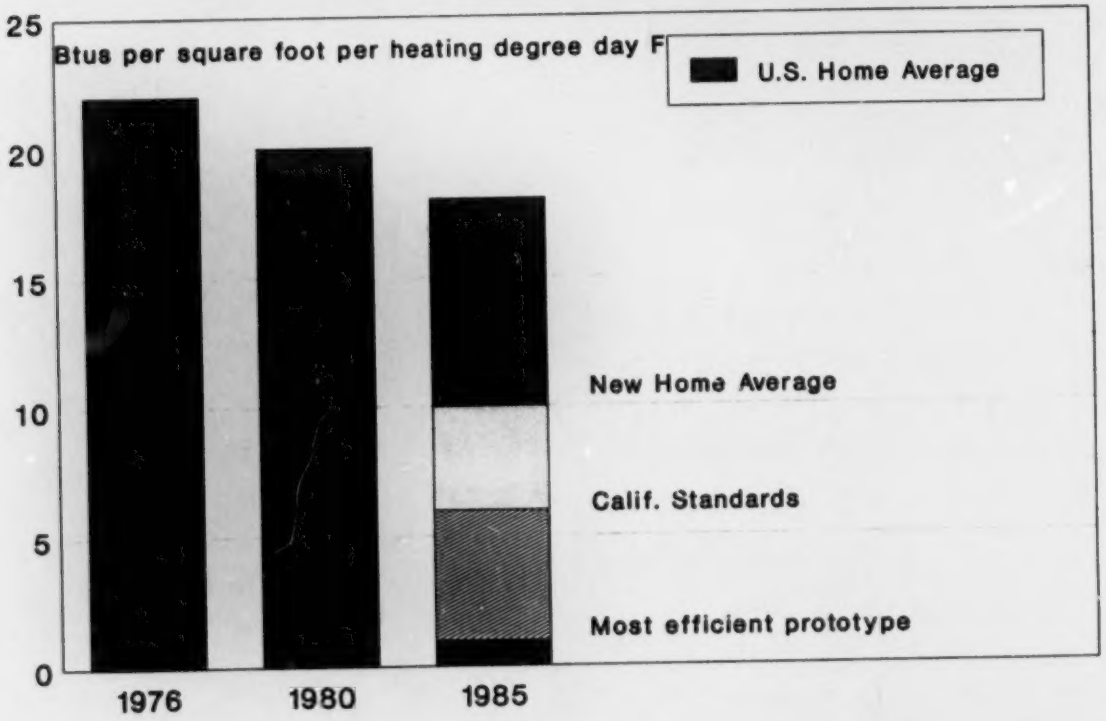
It seems to be an appropriate time to redouble our currently modest efforts to mine the considerable resource of energy efficiency still possible in virtually all sectors of the economy as well as preserve the

ability to develop renewable resources. The window of opportunity of low and stable world oil prices masks any sense of urgency, despite a once again rapidly growing reliance on foreign oil. The rationale for policy intervention favoring efficiency derives not only from concern over the level of oil imports per se, but also the national security concern over where future world oil production is concentrated, i.e., the Middle East, increasing concern over the environmental impact of burning fossil fuels, and the need to innovate in industry to be more competitive in world markets. All of these realities collectively serve to elevate the importance of policy initiatives aimed at further improving U.S. energy efficiency in spite of the current period of apparent stability. Important among these policy initiatives is continued attention to the RD&D agenda for energy efficiency. Even a broad policy approach aimed at improving U.S. economic efficiency will require continuing technical improvements in energy efficiency as one of its components.

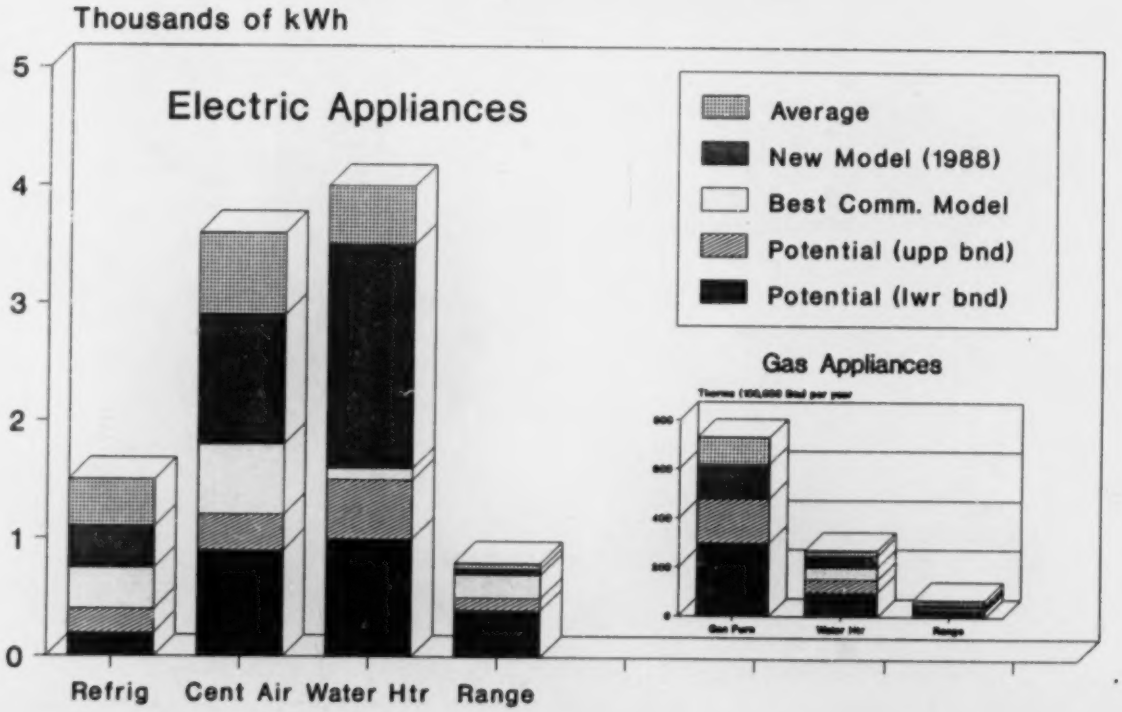
Renewable energy technologies also remain important elements of the Nation's long term energy supply strategy. Maintaining the potential for increased contribution to U.S. energy supply and even maintaining a viable industry infrastructure for these technologies will require sustained research and development support. Increased contribution of these technologies in the 1990's will require accelerated research, development, and particularly, demonstration.

U.S. Residential Energy Consumption

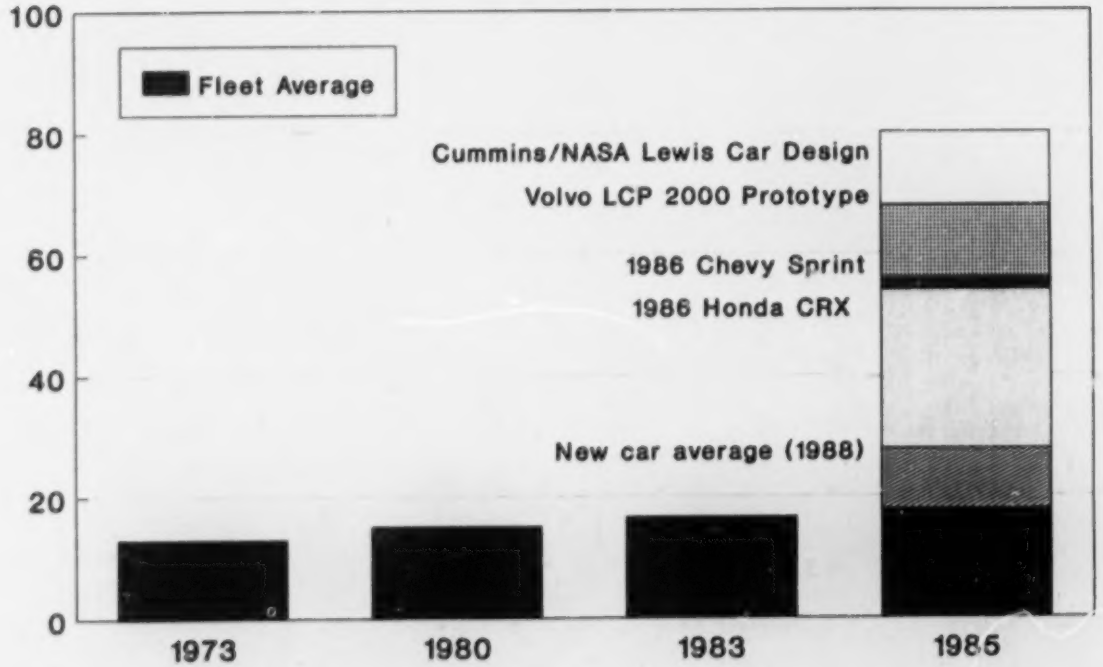
Energy to Heat a Single Family Residence



U.S. Residential Appliances
Energy Efficiency Potential



U.S. Automobile Mileage
(miles per gallon)



U.S. Industrial Energy Consumption
The Role of Energy Efficiency

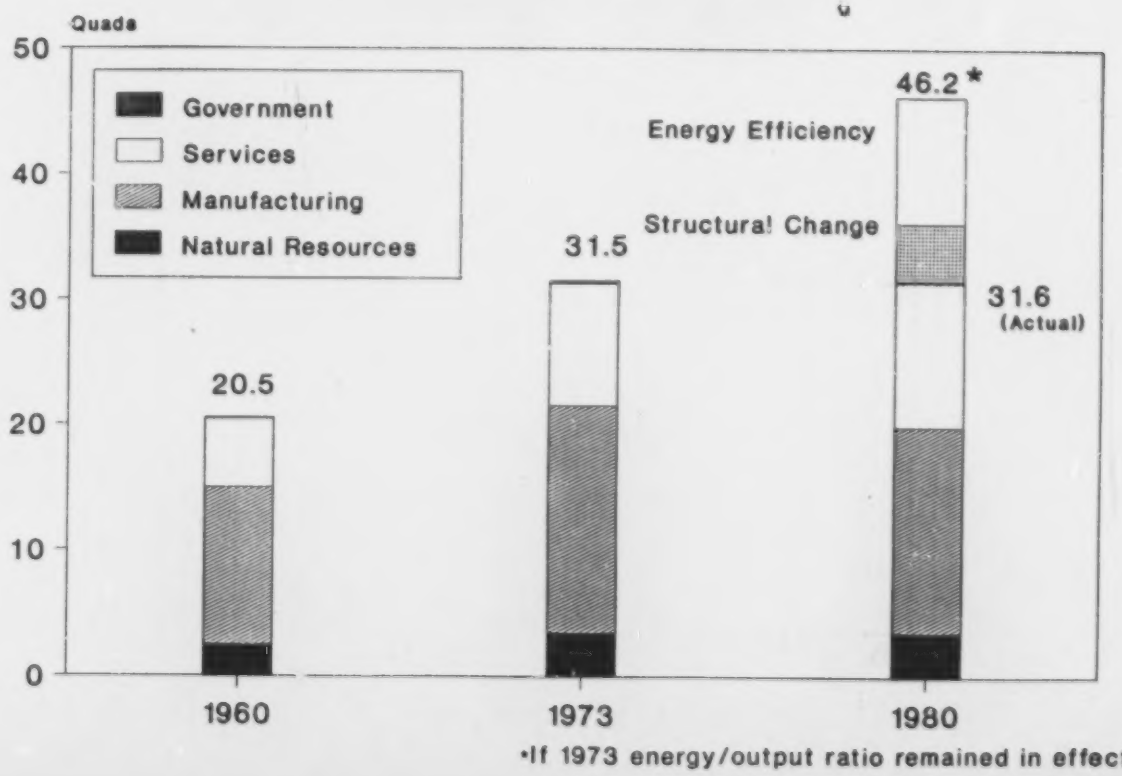


Table 1. .—Cross-Technology Comparison: OTA Reference Systems

Technology characteristics	Geothermal	Wind power	Photovoltaics	Solar parabolic dish[a]	AFBC	IGCC	Fuel cells	CAES	Battery storage
General									
Geographic location	Western U.S.	Entire U.S.	Entire U.S., South better	SW & SE	Entire U.S.	Entire U.S.	Entire U.S.	Entire U.S.	Entire U.S.
Plant size[b]	Small-medium	Small	Small	Small	Large	Large	Small	Medium-large	Small
Development status	Demo-commercial	Commercial	Demo-commercial	Demo	Commercial under construction	Demo	Demo planned	No Demo	Pilot
Lead time[c]	Short-medium	Short	Medium	Medium	Long	Long	Medium	Medium-long	Medium
Siting flexibility[d]	Low	Medium	High	Medium	Medium	Medium	High	Medium	High
Intermittent?[e]	No	Yes	Yes	Yes	No	No	No	No	No
Cost									
Cost[f]	Medium	Medium	High	High	Low	Low	High	Medium	Low
Profitable?[g]	No	Yes	No	No	Yes	N/A	No	N/A	N/A
Resource requirements and environmental impacts[h]									
Primary fuel source	Geothermal brine	Wind	Solar insolation	Solar insolation	Coal/solid fuels	Coal/natural gas	Natural gas	Base load electricity plus natural gas or oil	Base load electricity
Fuel availability	Limited	Limited number of quality sites	Region specific	Region specific	Not constrained	Not constrained	Not constrained	Not constrained	Not constrained
Noise	Medium	Medium to high	Low	Low	Medium	Medium	Low	Medium	Low
Solid waste[i]	Medium	Low	Low	Low	Medium to high	Medium to high	Low	Low	Low
Air quality	Medium to high	Low	Low	Low	Medium to high	Medium to high	Low	Medium	Low
Water quality[j]	Medium	Low to medium[k]	Low	Low	Medium	Medium	Low	Low	Low
Water consumption[l]									
Daily amount[m]	Low to high	Low	Low	Low	Medium	Medium to high	Low	Low	Low
Amount per MWe(net)[n]	High	Low	Low	Low	Medium	Medium	Low	Low	Low
Land use									
Areal extent[o]	Low	High	High	High	Medium	Medium	Low	Low	Low
Power density[p]	Medium to high	Low	Low	Low	Medium	Medium	High	High	High

[a]Engine-mounted solar parabolic dish.

[b]Sizes of OTA reference systems: Small = <25 MW; Medium = 25 to 100 MW; Large = >100 MW. For wind energy, experts felt at the time (see table 4-2, Alternative Generating Technologies and Storage) as to images, Type of Sizes and Applications.

[c]Short = <2 years, Medium = 2 to 5 years, Long = >5 years.

[d]Refers to the general ease of siting a powerplant. Ranking is based on combination of geographical location, fuel availability, and environmental characteristics. Low = plant can be sited only at specific locations. Medium = plant can be sited at many locations, but is constrained by local resource availability, etc. High = plant can be sited at most sites with relative ease.

[e]Refers to the overall reliability of the powerplant, primarily daily resource variability.

[f]Levelized cost (1983$) under most likely case scenario. Low = <7 cents/kWh, Medium = 7 to 14 cents/kWh, High = >14 cents/kWh.

[g]Whether technology can achieve a real rate of return (est. 15 percent in nonutility applications under most likely case scenario. Assumes no Federal Renewable Tax Credit.

[h]These potential environmental impacts are based on the reference plant sizes listed above and focus on direct impacts from onsite operation. Impacts associated with production of facility components, or disposal of worn components, are not considered.

Unless otherwise noted, the following rating system applies:

- High indicates substantial likelihood of large impacts requiring special measures to bring the facility into compliance with local, State, or Federal environmental protection statutes. High is also used to identify a strong potential for conflicting land use objectives and problems resulting from competition for scarce resources (e.g., for water in irrigation-dependent areas). In all of these cases, the resulting impacts could be serious enough to constrain full development of a site-specific energy resource.
- Where air emissions are considered, a high rating may be more reflective of local air quality conditions than actual emission rates. For example, location in a nonattainment area can affect development of any combus- ... just large enough to ... under Federal standards.
- Medium indicates that some special measures may be required to bring the facility into compliance with environmental protection statutes, but these conditions are not likely to seriously hinder development.
- Low means that environmental impacts are expected to be negligible.
- Combination ratings (e.g., low-high) indicate that: 1) impacts are likely to vary according to site-specific characteristics, and/or 2) impacts vary substantially with plant size.

[i]From daily plant operation only. Wastes associated with production and/or periodic replacement of power components are not considered.

[j]This includes any effluent discharge to surface water (e.g., lakes and streams); impacts on ground-water are not considered.

[k]Inadequate erosion control in steep terrain could lead to increased sedimentation in nearby streams.

[l]As explained in the following two footnotes, these ratings reflect the amount of water used rather than the consequent environmental impacts of water use. In areas with limited water resources and/or heavy competition for existing supplies, technologies with a moderate rating under this category may face siting constraints.

[m]Low = <1 million gallons per day, Medium = 1 to 3 gallons per day, High = >3 million gallons per day.

[n]Low = <3,000 gallons per day per MWe(net), High = 3,000 to 20,000 gallons per day per MWe(net), High = >20,000 gallons per day per MWe(net).

[o]These ratings are based on the land requirements for a 25 MWe(net) plant. They suggest where potential problems may arise regarding visual impacts, competing land uses, or habitat disruption. Low = ≤10 acres, Medium = 11 to 100 acres, High >100 acres. While extensive habitat disruption could occur on a small site (e.g., ≤10 acres), we have assumed that the affected area would be small enough that overall impacts on the resource in question would not be likely to constrain development.

[p]Refers to the amount of power produced per acre. Low = <0.5 MW per acre, Medium = 0.5 to 5 MW per acre, and High = >5 MW per acre.

SOURCE: Office of Technology Assessment.

New Electric Power Technologies: Problems and Prospects for the 1990s

Senator FOWLER. Thank you, Dr. Blair.

Before I forget, would you also give me your line-by-line comments on our two bills there, S. 1554 and H.R. 4226?

Dr. BLAIR. Certainly. I'd be pleased to.

Senator FOWLER. I was reading your statement. On page 10 at the bottom where you suggest that acceptance of new energy technology will require "even more emphasis on commercial demonstration of new technologies." How are we going to get there if the Federal Government doesn't put up the money for these demonstrations?

Dr. BLAIR. Well, if indeed the objective is to commercialize new technology as a matter of public policy, national policy, then the Federal Government has to participate in these new technology ventures. I think in particular right now when industry doesn't view energy efficiency or even renewable investments as a perhaps high priority item, the idea is to couple those investments with things that have other benefits as well, as I mentioned earlier. We can't really expect private industry to aggressively pursue new technologies for national security and environmental reasons. As an example perhaps, if current trends continue in energy efficiency, these investments will, indeed, occur I think over time.

Senator FOWLER. Will do what?

Dr. BLAIR. The energy efficiency investments will occur over time, but the rate at which that technology development and the accompanying capital turnover will not be sufficient to address a rapidly increasing level of imports.

So, I guess the answer to the question is how sensitive is our public policy to the rising tide of imports. Is that a still a matter of urgency or is it not? And if it is, then steps are necessary to accelerate commercial availability of the technology and the Federal role is very important.

Senator FOWLER. Am I correct that your graphs seem to suggest that without some kind of convincing demonstration of solar or energy efficiency technology that the technical potential of these improvements would not be realized in the marketplace? Or is that an erroneous reading of the graphs?

Dr. BLAIR. I think it is more a question—on the energy efficiency side, as I mentioned earlier, I think the technical potential will be realized eventually. But it's the rate that is of some concern. If we're interested in an accelerated rate, it will have to be tended to now.

On the renewable side, there is the danger of the eroding industry infrastructure that I talked about earlier. We are down to three major photovoltaics firms and the settling out of the wind industry is a rather dramatic trend over the last several years. So, the survival of that industry infrastructure may, indeed, mean that if it doesn't survive, renewable technologies that we buy in the 1990s will be Japanese.

Senator FOWLER. Senator Wirth?

Senator WIRTH. Thank you very much, Dr. Blair. I appreciate your being here. Thank you, Mr. Chairman.

You heard the earlier discussion by the Secretary related to the Department's priorities in solar. Do you agree with their priorities in the solar area?

Dr. BLAIR. The priorities in solar—I guess I still have actually a twofold view on solar. I believe that solar is a longer-term option perhaps than energy efficiency, for example, and that if indeed the objective is to deal with the shorter-term problem and the vulnerability issue, then only selected elements of solar technology are likely to contribute to that reduced vulnerability over the next several years or even perhaps a decade. Renewables will play a long-term role regardless of what we do I think over this next several years, and it's the rate of penetration that is of some concern.

So, I'm not sure I'm answering your question.

Senator WIRTH. No, you didn't. You heard what they said in terms of what commitments we were making in the area of solar, that effectively what we are doing, as I understood what she said, is going after fundamental power generation, what the Japanese are doing—you know, wrist watches. Is that right?

Dr. BLAIR. Well, let's take photovoltaics as an example. I believe that it is true that remote power applications are the sort of prize market right now as we wait for larger perhaps central station or grid connected power generation applications for photovoltaics perhaps as early as the 1990s. But the domestic industry needs to survive in order to be able to serve that market in the 1990s. So, aggressively pursuing even these short-term markets, the consumer electronics and others, is a very prudent strategy that the Japanese have taken in order to preserve their industry infrastructure.

Senator WIRTH. So, what you are suggesting by implication is that we are allowing the erosion of the industry infrastructure in the short term with the hope that somehow we're going to have something available for a longer term in remote power applications.

Dr. BLAIR. I guess I'd prefer to state it as the facts. The industry infrastructure is, indeed, eroding.

Senator WIRTH. Okay, well, that's part of the answer.

Are we doing what we ought to be doing in terms of remote power application research? Is the budget adequate to do the job? If that's the priority and other things are being stripped out, then one says, okay, if that's what we're focusing our time and attention on, is that being done in an adequate fashion?

Dr. BLAIR. I guess my the feeling is more could be done to capture those markets. More could be done to capture the near-term markets as well.

Senator WIRTH. Are we doing the kind of research in their budget that is adequate to meet the challenge or meet the opportunities?

Dr. BLAIR. We are doing the research side perhaps better even than the Japanese. The development and demonstration side—we're perhaps falling short. So, the Japanese may benefit directly from our research and development efforts and use perhaps even our technology to serve commercial markets.

Senator WIRTH. Switching the subject, has OTA done an analysis of what kind of commitments—I'm not quite sure how this question fits, but what kind of commitments we ought to be making in the area of energy conservation or could be making not just in the Federal Government's budget, but through encouraged efforts in the private sector and so on? Is there any kind of a picture of how big

that environment is, now promising that environment is, how much energy could be saved?

Dr. BLAIR. We are actually in the midst of doing that right now. We are involved in an assessment entitled Technological Risks and Uncertainties for Future U.S. Energy Supply and Demand. And one of the major focuses of that effort is to try to gauge how far we can go with energy efficiency in this new environment. The new economic environment we're in where the sense of urgency has diminished somewhat changes the perspective somewhat.

Senator WIRTH. When is that study going to be out, Dr. Blair?

Dr. BLAIR. We expect that it will be sort of in draft to go to our board late this fall, and it will probably be delivered at the beginning of the——

Senator WIRTH. So, we may get it in a year?

Dr. BLAIR. You'll get it January of next year, at the beginning of next session.

Senator WIRTH. How do you increase that sense of urgency?

Dr. BLAIR. Well, as a matter of policy, I guess the Congress has to decide if the sense of urgency is one——

Senator WIRTH. Why don't we just hang onto that for a second because we have some other witnesses who I suspect are going to have a similar perspective on that. Can you stay around?

Dr. BLAIR. Sure.

Senator WIRTH [presiding]. Now that I think that I am chairing this august assemblage, why don't we do the following? Let me ask the other three witnesses to come join us. Could we do that? Mr. Scott Sklar, the Executive Director of the U.S. Export Council for Renewable Energy; Mr. Nicholas Fedoruk, Director of the Energy Conservation Coalition; and Mr. Marc Ledbetter, the Director of the American Council for an Energy Efficient Economy. Gentlemen, we are very pleased to have you here today.

And let me do this if I might. We're going to have to turn into pumpkins here at 3:30. What I would like to do, if I might, is to ask each of you to summarize your statements. We'll include them in full in the record. And maybe you could do that in five minutes minus.

You all have heard the discussions that have gone on before. I think most of us have been through this. What I want to get at is where do we go from here. I mean, we all know that we've got a relatively hopeless situation probably in terms of budget commitments, but it seems to me there are a lot of things out there that ought to be done, and one of the key areas has to start with the question that Dr. Blair and I were just beginning on how do you get public attention up to the issue of energy conservation and related kinds of issues. So, maybe we could go with you, if we could, Mr. Sklar, then go to Mr. Fedoruk and then Mr. Ledbetter. If you guys could gallop, it would be deeply appreciated.

Mr. Sklar.

STATEMENT OF SCOTT SKLAR, EXECUTIVE DIRECTOR, U.S. EXPORT COUNCIL FOR RENEWABLE ENERGY

Mr. SKLAR. Galloping I go.

The U.S. Export Council is the umbrella group of eight of the Nation's renewable energy trade associations representing solar, wind, biomass, geothermal, hydropower, and passive solar. I brought three charts which basically capsulizes the basic thrust.

The funding for renewables in this country is at a close-down phase. The budget was $550 million in fiscal year 1981. We're at $96 million now. Germany is spending $61 million for photovoltaics, Japan $40 million, we $35 million, and OMB is planning to cut it to 24. There is no way we will be able to compete our photovoltaics industry when they are doubling their efforts to capture the world market no matter what DOE says.

India and the Netherlands are out-spending us in wind technology. And the budget in wind was cut 50 percent last year. It's down to $8 million and we've gone to the House side and I believe won it back up to $12 million to develop an intermediate wind turbine to compete in the 1990s.

The biofuels budget, the same, the greatest promise of many of the renewable resources in the nearer term. We already have 3,100 megawatts on line on the grid today, three nuclear power plants' worth. It has some real short-term implications, and they're cutting that down.

The European economic community spends $5 million for export promotion. And as you can see where the budgets have gone. These international energy agency countries—as the U.S., went down in the beginning of the 1980s, they're going up and, again, as Donna Fitzpatrick said, they are carefully selecting what they are picking, so they are not going up in all technologies. But the fact of the matter is they are sensing a world market and they're salivating at the U.S. retrenchment.

Finally, the cuts have not been equitable as you can see from the nuclear versus the renewables. That's fission and fusion, civilian only, versus renewables. And that has been our real problem here that we are at a close-out rate. We're only less than 13 percent of the nuclear budget. And if they cut it any more, it's just not worth doing. I mean, just zero it out and come clean.

Finally, I guess what I have always said is that we are sort of going through VCR syndrome here which is we have spent billions to develop this technology. Now just at the point we're about to realize its benefits in the world markets, we are essentially just handing it over to our international competitors. They're not doing anything sleezy, in fact. They're just grasping at a very good opportunity. And as a result, we will be buying it back for billions of dollars in the 1990s and in the year 2000 as a result if this process continues.

The industry is in a close-down mode. There are very few companies. We have catalogs here of the industry. But they are strong, and if we can retrench and pass some of this legislation that Senators Fowler and Bumpers and Hatfield have introduced promoting these technologies, I think we may have a turnaround and can lead technologically.

Thank you.

[The prepared statement of Mr. Sklar follows:]

US/ECRE
UNITED STATES EXPORT COUNCIL FOR RENEWABLE ENERGY P.O. BOX 10095 ARLINGTON, VA 22210-9998 703 524 6104

American Wind Energy Association
Cogeneration & Independent Power Coalition of America
National Hydropower Association
National Wood Energy Association
Passive Solar Industries Council
Renewable Fuels Association
Solar Energy Industries Association
Volunteers in Technical Assistance
Wood Heating Alliance

TESTIMONY

by

SCOTT SKLAR
EXECUTIVE DIRECTOR
U.S. EXPORT COUNCIL FOR RENEWABLE ENERGY

before

SUBCOMMITTEE ON ENERGY RESEARCH & DEVELOPMENT
SENATE COMMITTEE ON ENERGY & NATURAL RESOURCES

MAY 18, 1988
WASHINGTON, D.C.

INTRODUCTION

The U.S. Export Council for Renewable Energy (US/ECRE) is the national umbrella organization of the U.S. renewable energy trade associations promoting exports of alcohol fuels, biomass, cogeneration, geothermal, hydropower, passive solar, photovoltaics, solar thermal, wind and wood energy technologies and services. We strongly urge level R&D funding for FY'89 and passsage of S.1320, S. 1554 and S.1930, all of which represent important attempts to resurrect a United States renewable energy and conservation policy. Introduction of this legislation is opportune in the face of increasing competition from abroad -- particularly by other industrialized nations who are our competitors, and sense a lessening of resolve by the United States to commercialize our solar and renewable energy research.

In fact while the United States cut our photovoltaics research from $153 million in FY'81 to $35 million in FY'88, our strongest competitors Japan and Germany spend $43 million and $61 million respectively. While the United States cut our solar thermal power research from $120 million in FY'81 to $17 million in FY'88, our European competitor nations have established a consortium, Phoebus, to aggressively market this new technology abroad. While the United States cut funding in wind energy research in FY'81 from $83.7 million to $8.3 million in FY'88, India and the Netherlands now spend more and have increased their world market share accordingly. While the United States cut biofuels research in FY'81 from $57.7 million in FY'81 to $17 million in FY'88, Sweden, Japan and others are moving to control the world markets. And while the United States cut solar buildings research from $75 million in FY'81 to $5 million in FY'88, the United States has one million solar water heaters while the City of Tokyo alone has more installations. The European Economic Community directs more than five times more funding towards government-support renewable energy export promotion than does the United States.

Unless the United States research priorities are refocussed, the U.S. may face a replay of "VCR Syndrome". Simply put, "VCR Syndrome is where America gives away its technological predominance in a technology we created, only to purchase it back in later years from our competitors for millions, if not billions, of dollars more than we originally paid to develop the technology. The Administration's research philosophy -- to fund only long-term, high-risk research involving an industry that is primarily composed of small businesses and is under-capitalized -- is not a sound government strategy for the renewable industries. A levelized and stable federal R&D program represents an important step towards redirecting our government programs towards pushing research to market development -- a step that is truly needed.

STATUS OF THE UNITED STATES RENEWABLES INDUSTRIES

The United States photovoltaic industry annual terrestrial sales hover around $200 million per year. Currently, over sixty percent (60%) of U.S. technology is exported and our companies have nearly half the world market. However the drop in U.S. world market share from eighty percent (80%) in 1981 to fifty percent (50%) in 1988 is not just due to an expanding international market. Our international competitor nations are much more strongly supportive of their industries' efforts to capture international markets.

The United States wind industry continues to mature. Energy production per kilowatt of installed capacity rose from 660 kilowatt-hours (Kwh) in 1985 to 920 Kwh in 1986, a 40% increase, and to 1100 Kwh by 1987, another 20% increase. The 1987 year marked the sixth consecutive year of increased capacity and increased productivity. Total windfarm power output rose from 670 million Kwh in 1985 to 1.2 billion Kwh in 1986 and 1.7 billion Kwh in 1987 -- a 150% increase in the last two years. The turnkey installed cost of a windfarm at the end of 1987 was slightly less than one-third what it was in 1981.

The United States solar thermal power industry has annual sales approaching $150 million. Over 160 MW of electricity of solar thermal power is now produced in California. Several large commercial-scale industrial process heat applications are operating throughout the United States. As mentioned earlier, the governments of Spain, Sweden, Germany, among others, in partnership with industry have established a consortium to market stretched membrane technology worldwide, primarily to North Africa. Although the U.S. developed and leads in this technology, only limited resources have been made available by the U.S. Congress to commercialize this important technology. The use of stretched foils has not only dramatically brought down the cost of electrical generation, but the technology has also near-term use for toxic waste destruction and power production for the space station.

Solar hot water technology sales have topped $100 million in 1987 and sales should increase substantially in 1988. Purchases of solar hot water systems in the pool heating and new home construction markets are the main reasons for the sales increases. Efforts by industry to increase sales through federal and state government procurements and incorporation of solar in conventional housing loan programs (FHA,VA,FmHA) could double sales within the decade.

The U.S. wood industry provides over 3100 megawatts of electricity, and another 700 megawatts are produced from municipal and agriculutural wastes. The industry had exponential growth until tax credits expired and utility interconnection was clouded by recent proposals by the Federal Energy Regulatory Commission. Since 1980, 150 ethanol production facilities have been built and production increased from 38 million to 460 million gallons. Ethanol blended fuels now supplies 50% of the U.S. gasoline market.

FEDERAL GOVERNMENT PROGRAM SUPPORT & GOALS

Our international competitors are salivating at the prospect of a U.S. retrenchment in solar and renewable energy development. Many international experts conclude that a multibillion dollar market exists for renewable energy R&D. The U.S. industry needs a stable and supportive federal R&D program. The Subcommittee must establishe a set of multiyear R&D levels following the proposed legislation which the U.S. Export Council for Renewable Energy (US/ECRE) and our member trade associations heartily endorse. The multiyear authorization levels for biofuels, wind, photovoltaics, solar buildings, solar thermal power, and international (CORECT) export activities are adequate and represent a reversal of policy. Earlier, the Administration and Congress have sought to cut these programs to comply with Gramm-Rudman-Hollings even though such cuts would place these programs in a closeout mode.

The technical objectives of the U.S. Department of Energy programs have been met. For instance, all of the cost and efficiency goals of the first PV five-year plan have been met or exceeded. The industry has every expectation to exceed cost and performance goals in this newly instituted US/DOE five-year plan. Efficiencies in amorphous silicon multijunction cells have broken new records in 1988 at 12.4% and 13.3% respectively.

In the wind energy program, a special initiative is needed to develop a new advanced intermediate-sized wind turbine. Development of such a turbine, based upon the solid research base already in the program, will allow American industry to remain competitive in the new and growing international market for power supply in the 1990's.

In the solar thermal power program, a new record in solar thermal concentration has been achieved through work supported by the Solar Energy Research Institute. A solar intensity of 60,000 suns has been achieved, which is greater than any previous attempt, leads the way to energizing lasers, development of stronger and durable materials, and disposing of hazardous wastes, chemicals, and nuclear fuels. Stretched membrane technologies has cut the weight by a factor of three cutting materials costs in half. In solar buildings, technical tools are now available to predict thermal performance of both passive solar features and active solar heating equipment. These predictors will allow architectural, design, and engineering firms to accurately incorporate this equipment in commercial projects.

While the U.S. interagency export coordination effort, the Committee On Renewable Energy Commerce and Trade (CORECT) has been well managed by the U.S. Department of Energy, the level of support must be broadened. The $1.5 million level for international export promotion is the bare minimum to carry out a successful effort. CORECT's goals and administration are sound. Close cooperation with the U.S. Department of Commerce is essential to insure that the activities are market oriented.

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Finally, in the biofuels program advances in converting lignocellulosic feedstocks from waste using thermochemical conversion and biochemical conversion are very promising. Greater emphasis is needed in direct combustion regarding wood ash disposal, combustion of unclean wood, woo/coal cofiring, and statistical informaion. The regional programs must be ontinued as the only mechanism in this program to transfer the technology to the industry. Aquatic energy crop and hydrogen research should be discontinued due to the drastic budget cuts. Efforts to continue this research will hurt the program.

The United States biofuels, wind, photovoltaics, solar thermal power and solar hot water industries are growing despite low energy prices, expiration of tax incentives, and lessening federal support in R&D and loan-subsidy programs. However this growth rate is dwarfed by the growth of our competitors who have greater government support in a myriad of areas. Other governments have more collaborative federal R&D programs with the goal of short-term commercialization.

From the renewable industries' perspective, the technical goals of the US/DOE programs are sound and do not need to be modified. The Administration's policy of support of mainly long-term, high-risk research is not sound and must be redirected. Requirements which direct the U.S. Department of Energy to report to the U.S. Congress on their technical performance goals and to develop a strategic plan are important as a way to insure that the programs remain relevant and to increase Congressional oversight and understanding. However, the U.S. Congress, in fact, ought to direct the Department of Energy and the Office of Management and Budget to make these recommendations and plans in response to Congressional objectives in addition to their own.

The establishment of a special joint venture fund to promote solar and renewable energy projects are laudable. Government-supported demonstration projects have had limited utility because many of the companies involved did not have an economic commitment to the projects' long term operation. The idea of brokering a project with federal and private sector monies is good energy policy. Such ventures will attract new investment capital to this undercapitalized industry but they must allow state and local government contributions to offset industry contributions. In this way, many small businesses that have developed useful solar technology but lack resources could qualify if the state or local governments believe in its applicability or because the venture builds the local economy.

Because the renewable energy industry is predominantly small business, in-kind contributions including donations of labor, land, and licensing must be included as part of the industry contribution to the proposed joint venture. Since the majority of solar companies are less than fifteen years old and do not have the assets, capital, or other collateral that older, more coventional industries have -- in-kind contributions are an important aspect. However, a level renewable energy R&D budget is essential before any joint venture programs are established.

Finally, coordination of research & development and joint ventures with other federal entities including the Environmental Protection Agency, National Aeronautics and Space Administration, Small Business Administration, Department of Commerce, Department of Housing & Urban Development, Department of Defense and other federal entities would greatly increase the success of the R&D program and joint ventures. If joint R&D and coventures can leverage funds from other federal agencies which fit into their mission or program goals, these projects will more easily attract private capital.

Multiyear funding proposed in the legislation (S.1320, S.1554, S.1930) is worth Congressional support because it develops the kind of industry/government partnership so important if the U.S. renewable energy industries are to compete successfully in the international arena. Our industries cannot hold world markets if we are unable to maintain a sizeable and expanding foothold in our own domestic markets.

CONCLUSION

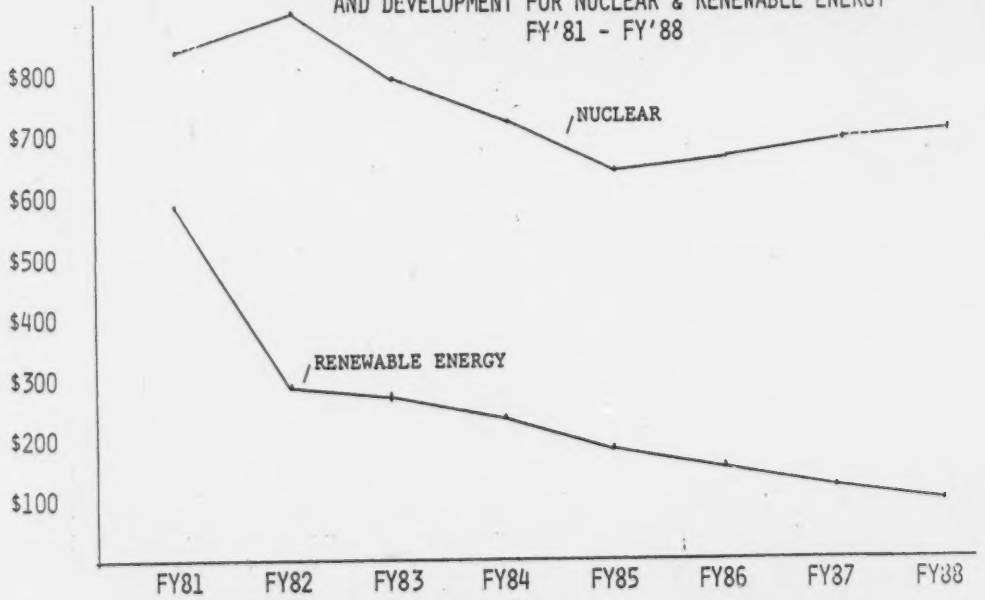
The U.S. Export Council for Renewable Energy (US/ECRE) urges a levelized funding strategy lasting for several years focussing on transfering technology to the existing renewable energy industry. Such a policy exemplifies an important Congressional policy initiative to reorient the U.S. federal research and development program away from esoteric R&D to practical R&D that will help U.S. industry build our international markets.

The directives in the legislation to require the U.S. Department of Energy to report to the U.S. Congress on their technical performance goals, developed in consultation with industry, is a useful tool to focus the program. Further requirements to establish a solar and renewable energy strategy in the National Energy Policy Plan is also useful since renewable energy has been receiving decreasing attention in that plan.

Joint venture projects will be useful if industry in-kind contributions are allowed to offset capital contributions. In addition, federal agencies other than US/DOE and state and local governments should also be allowed to "buy down" the industry contribution. In this way, the predominantly small business solar industry will be able to successfully join such government/ industry partnerships and attract capital.

Finally, the multiyear authorization levels for biofuels, wind, photovoltaics, solar buildings, solar thermal power, and international export promotion, are essential if the U.S. industry is to be secure and maintain our technological predominance internationally.

ACTUAL APPROPRIATIONS FOR U.S. DEPARTMENT OF ENERGY RESEARCH
AND DEVELOPMENT FOR NUCLEAR & RENEWABLE ENERGY
FY'81 - FY'88



NUMBERS EXPRESSED IN MILLIONS OF DOLLARS AND ARE ACTUAL CONGRESSIONALLY-APPROVED APPROPRIATIONS FOR RENEWABLE ENERGY AND NUCLEAR ENERGY

RENEWABLE ENERGY INCLUDES SOLAR BUILDINGS, SOLAR THERMAL, PHOTOVOLTAICS, BIOFUELS, WIND, OTEC, SERI, TECHNOLOGY TRANSFER

NUCLEAR ENERGY INCLUDES NON-MILITARY US/DOE R+D PROGRAMS AND NOT INCLUDING AVLIS OR NUCLEAR WASTE REPOSITORY ESTABLISHMENTS

VARIATIONS MAY OCCUR REGARDING CARRY-OVER MONIES AND THE INCLUSION OR OMISSION OF CERTAIN LINE ITEMS BUT OVERALL NUMBERS ARE CORRECT

U.S. DEPARTMENT OF ENERGY SOLAR & RENEWABLE ENERGY R&D APPROPRIATIONS FY'81 - FY'87

Prepared by Scott Sklar

October 1987

	FY'81	FY.82	FY'83	FY'84	FY'85	FY'86	FY'87	FY'88
BIOFUELS	57.7	30.5	21.0	28.4	31.0	27.3	24.0	17.0
WIND	93.7	34.7	31.4	26.5	29.1	24.8	16.7	8.1
PHOTOVOLTAICS	[illegible]	[illegible]	[illegible]	[illegible]	57.0	40.6	40.4	35.0
SOLAR BUILDINGS	74.9	22.1	11.7	16.4	9.9	8.2	5.9	5.2
SOLAR THERMAL	119.9	54.9	49.5	40.8	35.[illegible]	25.8	22.9	17.0
INTERNATIONAL	12.0	4.0	10.0	5.5	0.[illegible]	0.9	0.8	7.5
TOTAL	$557.1*	$276.4	$201.6	$179.6	$165.	$144.6	$123.5	$96.9

NOTE:

1. Numbers express in "millions of dollars".
2. Budget line-item include operating expenses and capital equipment and are rounded off to the nearest decimal.
3. Total renewable budget does not add due to other line items not included such as SERI, Resource Assessment, Program Support, Program Direction and fiscal year carry-overs, etc.
4. Biofuels figures combine alcohol fuels and biomass line items in early fiscal years since programs were combined later.
5. Solar buildings figures combine passive and active solar line items in early fiscal years since programs were combined.

(*) FY'81 program was $220 million larger due to other programs not carried out in later years regarding commercialization and public information programs.

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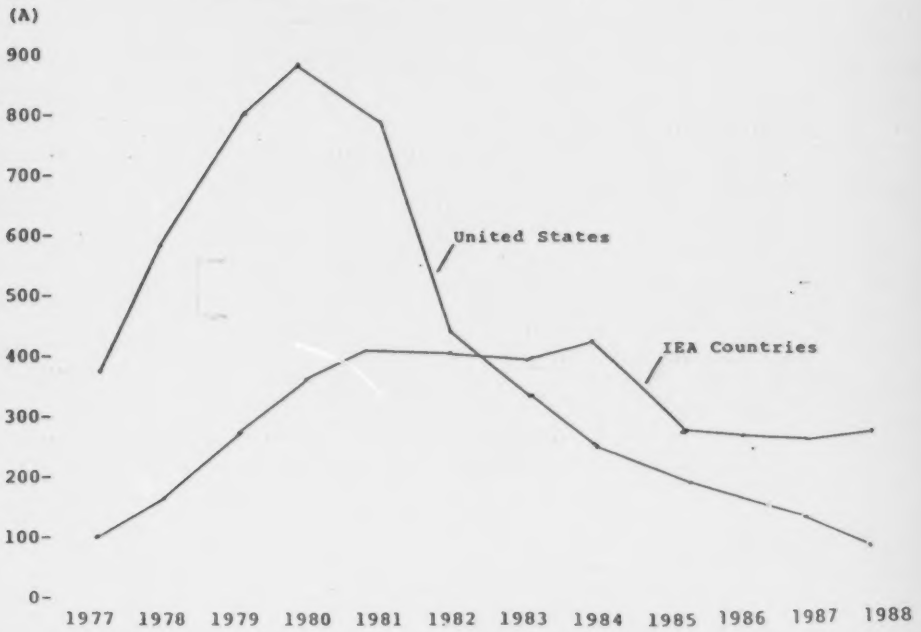
US/IEA GOVERNMENT R&D BUDGETS FOR RENEWABLES IN 1985
US DOLLARS (1977-1988)



IEA COUNTRIES: Australia, Austria, Belgium, Canada, Denmark, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdon

AXIS (A): In millions of U.S. dollars

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RENEWABLE ENERGY ELECTRICAL GENERATION IN THE UNITED STATES AS OF MARCH 1988

Anaerobic Digestion	17.94 MW
Geothermal	1,578.80 MW
Landfill Gas	49.82 MW
Municipal Solid Waste	630.60 MW
Photovoltaics	13.27 MW
Solar Thermal Power	110.25 MW
Wind	1,223.20 MW
Wood/Agricultural Waste	3,189.26 MW
TOTAL	6,813.14 MW

* Does not include hydropwer (approx 73,000 MW)

** Does not include plants under construction (approx 2,500 MW)

*** Does not include conservation and energy management applications installed with renewable eergy options

Senator FOWLER. Thank you.
Mr. Fedoruk.

STATEMENT OF NICHOLAS A. FEDORUK, DIRECTOR, ENERGY CONSERVATION COALITION

Mr. FEDORUK. Before I start, I want to express my appreciation, Senator Wirth, for your public statement in support of the alternative energy conservation budget that you made earlier this year. We believe that the alternative energy conservation budget, in fact, is a much better answer to the Nation's energy needs than the one which is proposed by this administration.

I am going to talk in general about the budget, and Marc Ledbetter is going to talk about some of the past successes that have been realized in energy conservation R&D and the confidence this gives us in some of the initiatives that we have recommended in the alternative budget.

Senator WIRTH. We can all read your testimony.

Mr. FEDORUK. Right. I'm not going to go into it.

Senator WIRTH. What I really want to get at between all of you is where we go from here.

Mr. FEDORUK. Right.

Senator WIRTH. We have four experts here who have spent an awful lot of time working on this.

Mr. FEDORUK. Let me talk to some——

Senator WIRTH. Past successes we're aware of.

Mr. FEDORUK. Right.

Senator WIRTH. We think they are very praiseworthy. They're wonderful things.

Mr. FEDORUK. Let me talk to some areas then.

People talk about cost effectiveness. We think that it is urgent for the government to begin the process of least cost energy planning as an energy strategy because this is the only way we're going to have a sound energy budget and not have the kind of budget that was being discussed earlier. That takes substantial technical evaluation. It takes substantial data development. And that could be very important.

In terms of international competitiveness, I think you have heard already that there is clearly a need to rebuild our technical base in virtually every area of energy efficiency. I think at this point we are beginning to see the effects of the underfunding that we have had for the last seven years. It looks from the information from the Energy Information Administration that, in fact, the efficiency of the American economy has leveled out in 1987. And that is the reason that we recommend this year a 17 percent increase in energy efficiency R&D, and we think that that kind of increase would be justified for the next several years, which is not what you would find in the Fowler bill. We would recommend the out-year numbers in the Fowler bill be increased.

In terms of oil imports, we recommend a budget of $8.7 million for transportation. We, very much in the line that Dr. Blair has been talking, would recommend that that be a collaborative effort, that it put a lot of emphasis on realizing the potential benefits of

near-term technologies, that we both develop and demonstrate those technologies so that they are available in the 1990s.

In fact, just to comment on the earlier presentation, we think that the problem with the alternative fuels study is that it doesn't look at the major alternative fuel which is energy efficiency. There is more promise in energy efficiency in this century than there is from any of the other alternative fuels.

In terms of the environment, I think you already got into quite a colloquy on the global warming issue. I think that there is clear need for us to increase our efficiency particularly in the use of fossil fuels. There have been estimates that if we could set ourselves a target of increasing efficiency on the average 1 and a half percent per year, we could significantly undercut the nature of this problem. We might even be able to slow it down completely. That seems to be quite feasible if we have the commitment to do it. We did better than that, significantly better than 2 percent, in fact, over the last 10 years.

[The prepared statement of Mr. Fedoruk follows:]

88-735 0 - 88 - 5

ENERGY CONSERVATION COALITION
1525 NEW HAMPSHIRE AVENUE, N.W. WASHINGTON, D.C. 20036

NICHOLAS A. FEDORUK, DIRECTOR
ENERGY CONSERVATION COALITION

ALTERNATIVE ENERGY CONSERVATION BUDGET FOR FY 1989

THE SENATE ENERGY AND NATURAL RESOURCES SUBCOMMITTEE
FOR ENERGY RESEARCH AND DEVELOPMENT

MAY 18, 1988

NICHOLAS A. FEDORUK, DIRECTOR
ENERGY CONSERVATION COALITION

ALTERNATIVE ENERGY CONSERVATION BUDGET FOR FY 1989

THE SENATE ENERGY AND NATURAL RESOURCES SUBCOMMITTEE
FOR ENERGY RESEARCH AND DEVELOPMENT

MAY 18, 1988

I appreciate the opportunity to testify before the Energy Research and Development Subcommittee on the energy conservation research and development budget for fy 1989. My name is Nicholas A. Fedoruk, and I am testifying on behalf of the Energy Conservation Coalition (ECC). ECC is an alliance of twenty national public interest organizations that share a common determination to significantly increase America's energy efficiency. The Energy Conservation Coalition is affiliated with the Environmental Action Foundation.

I will discuss some major challenges of the current energy situation that shaped the development of the Alternative Energy Conservation Budget for 1989. Marc Ledbetter of the American Council for an Energy Efficient Economy (ACEEE) will discuss energy conservation research and development initiatives proposed in the alternative budget.

The alternative budget, which has been endorsed by 28 national organizations, represents a modest proposal for restoring balance to the federal energy budget. It should be viewed as a first step toward significantly higher levels of funding for energy conservation that sound energy and economic policy dictates.

The Alternative Budget for Energy Conservation for FY 1989 recommends a total of $439.2 million for federal energy conservation programs, a

sixteen per cent increase above FY 1988 appropriations and almost four-and-a-half times the Administration's request. Energy Conservation Research and Development (R&D) would receive $192.1 million.

FEDERAL ENERGY PRIORITIES

It is time to revitalize the deteriorating federal commitment to energy efficiency, particularly in energy research and development. Energy efficiency deserves special attention because it is so effective at improving our position in so many critical areas: cost-effectiveness, international competitiveness of US industry, oil imports, environmental quality, and quality of life for low-income and disadvantaged households.

Meeting Energy Needs Cost-Effectively:

We already are saving $130 million per year due to increased energy efficiency. We could save an additional $80 million per year or more, using methods which are less costly than acquiring energy from conventional supplies.

To realize these kinds of opportunities, the federal government needs to shift its energy strategy towards assuring energy services at the lowest cost. Generally people are interested in having the goods and services that energy can provide, not in having energy. If we can have an improving standard of living at lower energy cost, so much the better.

In order to implement this new strategy, the Department of Energy needs to take a page from the successful least-cost electricity planning being practiced by utilities nationwide. DOE must conduct analyses which

provide supply curves of conserved energy and electrical power as well as supply curves for energy power and development so that one can compare the cost-effectiveness of investments. The Federal Least-Cost Energy Plan should serve as the foundation of energy-related budget request from all departments and leasing and other federal decisions on energy development and use.

Improving America's International Competitiveness:

The United States spends approximately $440 billion on energy every year, 11% of our GNP, far more than our trade competitors in OECD. The Japanese spend 5% of their GNP on energy and are improving their efficiency more rapidly than we are. This contributes to our competitive disadvantage in international trade as does the fact that we offer few products that are competitive at world energy efficiency levels.

Continued advances in energy-saving technology can play a key role in assuring the competitiveness of U.S. industry in the world market. Unfortunately it appears that underfunding of energy conservation research and development is beginning to take its toll. According to Energy Information Administration reports, 1987 may be the first year in the last decade in which the energy efficiency of the U.S. economy has not improved.

Since 1980, we have cut the federal energy conservation r&d budget by two-thirds in real dollars. It is time to rebuild our technical base in energy efficient lighting, heating, air conditioning, motors, appliances, manufacturing equipment, and industrial processes.

Reducing Oil Imports:

Increased efficiency of oil use is the major, feasible low-cost method to protect the U.S. economy from ruinous price increases in the mid 1990's. Supply alternatives are inadequate, costly and environmentally damaging. Currently, the United States is the major importer of world oil. The United States consumes approximately one third of the oil produced by market economies. Our oil imports have increased from 27% in 1985 to 35% by 1987. This represents a 35% increase in net imports in two year.In 1987, oil imports accounted for more than 25% of the U.S. trade deficit. If the U.S. economy still consumed oil and gas at 1973 rates, oil imports would have comprised 55% of the trade deficit or more.

Future oil import increases pose the threat of a return to past oil prices or worse. The experience of the 1970's and 1980's has demonstrated that whenever OPEC reaches more than 80% of its oil production capacity, the world economy is vulnerable to cartel prices, supply disruptions, and price shocks in this politically volatile region.

Data Resources, Chase Econometrics and the National Petroleum Council estimate that by 1995 US oil imports will be between 58% and 66%. This would be approximately 10-11.5 million barrels of oil a day (mbd). As a whole, worldwide oil consumption is expected to increase 6% to 15%, depending on the price of oil during this period.

Non-OPEC sources of supply to the world oil market are expected to decrease. U.S. oil production is projected to decline as low as 4.0 mbd before the end of the century. North Sea production is expected to decrease by 9% and other historically more reliable producers, such as

Mexico and Canada will be decreasing their exports due to decreasing reserves or increasing domestic consumption.

If nothing more than "business-as-usual" actions are taken, these trends will probably produce sharp price rises in the mid-1990's. Within this short time, energy efficiency is the reserve with the greatest potential for meeting US needs.

It makes economic sense to emphasize a focused program of improving the efficiency of our automobiles, trucks, buses, trains and airplanes, since transportation accounts for 63% of US oil consumption. In 1986 transportation alone used 10% more oil than was produced in the United States. Automobiles and light trucks (currently consuming 63.4% of the petroleum in the transportation sector) are the prime target for energy savings in the transportation sector.

If we are to accelerate the contribution of energy efficiency in transportation, we need to dramatically increase federal investments in cooperatively financed transportation efficiency research and development. Since 1980 the Department of Energy's budget for transportation research and development has been cut in half. The private sector has followed the government's lead rather than filling the gap. Clearly, the vital nature of transportation efficiency calls for a return to funding levels similar to those of the late 1970's. We are seeking to increase last year's appropriation for energy conservation r&d in the tranportation sector by $8.7 million, a 17% increase above a very low base.

The private sector must be included as partners to bring near-term improvements into the market as rapidly as possible. This should include

the innovative small research businesses and universities -- which to date have often had to exchange licensing rights for overseas funding.

The research should be targeted to increase US competitiveness in the 1990's and encompass production processes as well as well as improved automobiles, trucks, buses, trains and airplanes. Efficiency improvements can be made in all modes of transportation through technical improvement. In addition to engine improvements, efficiency can be increased by improved aerodynamics, strengthened lightweight materials, beltless continuously variable transmissions, substitution of electronic controls for mechanical controls, improved lubricants and more. Recent studies estimate that the U.S. could increase the efficiency of new car fleets to a discounted value of 40 mpg at a cost of eighty cents per gallon saved.

Improving Environmental Quality:

Energy conservation reduces energy use and thus decreases environmental harm resulting from exploration, production, transportation, and consumption of energy. Increased efficiency can also reduce the cost of pollution abatement. For example,a collaborative study by ACEEE and ECC has shown that using accelerated electric power conservation can more than pay the costs of acid rain clean-up in the dirtiest region in the country.

However, of all the environmental problems we face, the "greenhouse-effect" is the most poses the most daunting challenge. Although the worst effects will occur in the next century, ameliorative action must be taken now, and energy efficiency is the essential keystone of the corrective strategy.

Increasing amounts of carbon dioxide and other greenhouse gases in our atmosphere are forming a transparent barrier which permits solar radiation to reach the earth's surface, but then prevents the resulting infra-red rays from radiating into space. This increases the warming of the earth's surface.

If we continue to use fossil fuels the way we do today, atmospheric concentrations of carbon dioxide will double in the next 50 to 100 years. Other greenhouse gases such as halons, methane and chlorofluorocarbons will probably accelerate this timetable.

The expected change in temperature, 1.5-4.5 degrees centigrade, will cause drastic changes in weather patterns and glacial melting resulting in at least a foot's rise in the sea level. This would pose a major threat to populations in coastal cities (e.g. New Orleans, Miami, Los Angeles, and Manhattan). We would also be coping with weather systems not seen in recorded history.

If we are to prevent these problems we cannot wait to see their effects, we must act now. There is no control technology to reduce carbon dioxide emissions. Ultimately, we must replace fossil fuels, but now the most promising method is to increase the efficiency of combustion and thereby decrease use. It has been estimated that if we could increase the efficiency of fossil fuel use by 1.5% per year we could minimize the danger of temperature increases. Given the fact that we have done better that up until 1987, this seems to be a feasible target, if we reinvigorate our energy efficiency efforts.

Improving Quality of Life for Low-income and Disadvantaged Households:

Low-income households face hardships in coping with rising energy prices. Since they must limit themselves to the bare necessities; any increase in the price of food, clothing, shelter, health care, and energy forces painful trade-offs. These households cannot afford to pay for efficiency improvements. In effect, they are forced to waste energy and to take the largest "hits" when energy prices rise. In 1986, low-income households used 14-15% of their income for energy bills, three times the national average.

Weatherization programs using improved retrofit techniques can mean increased food, clothing, and comfort for our most vulnerable citizens. Typically, investing $1,000 to increase the energy efficiency of low-income and fixed-income households can reduce their annual energy bill by $200 or more for more than 20 years.

The current Weatherization Assistance Program, hampered by limited funds, is engaged in a job which will never be completed. Long before they have completed retrofits for their target audience, earlier retrofits will need to be redone. If we are to have a fighting chance with constrained budgets, we must make use of the best program practices and increase the effectiveness of our technical investments. This requires a positively focused programmatic and technical evaluation, as well as enhancement of low cost retrofit techniques.

CONCLUSION

We urge the Congress to reject the Administration's minimal request for federal energy conservation programs and provide funding commensurate with national needs and energy efficiency opportunities. As stated above, energy conservation is the easiest and most economical way to meet U.S. energy needs. It reduces oil imports, improves U.S. international competitiveness, improves environmental quality, and helps reduce the burden on those with low and fixed incomes. We believe that the Alternative Energy Conservation Budget for FY 1989 is a modest step towards revitalizing our energy efficiency. We ask you to take that first step.

In 1980, $343.8 million was appropriated for energy conservation research and development. Since then the appropriations have been cut in half. This amounts to a two-thirds cut in uninflated dollars. The Department of Energy must use its conservation funds to exercise leadership and work in partnership with the private sector to accelerate investment in energy efficiency research,development,and demonstration.

The department must also exercise international r&d leadership. Increased international energy efficiency will counteract the trend toward control of the international oil market by the Persian Gulf states. International energy efficiency is also critical for dealing with global warming and other climatic concerns that cannot be resolved by the United States alone.

Senator WIRTH. Do you have anywhere laid out or has anybody done how you would get to a 1 and a half percent——

Mr. FEDORUK. We do not have a specific program, but we believe that the alternative budget, which we have recommended and which goes line by line—it is not just a summary document, but is a line item by line item document—is a start for that.

We also, by the way, believe that there are some very useful recommendations in the multiyear plan that has been developed by the Department itself, which is another——

Senator WIRTH. Do any of you know of a program that has been put together to get to a 1 and a half percent reduction like that? This is going to go to a later question.

Mr. LEDBETTER. Yes.

Senator WIRTH. Mr. Ledbetter?

Mr. FEDORUK. We, in fact——

Senator WIRTH. You're going to get to that. Why don't you finish very briefly?

Mr. FEDORUK. Well, in fact, Marc and his organization have been undertaking a major effort in which I have participated as well, and maybe I will let Marc speak to that.

STATEMENT OF MARC LEDBETTER, DIRECTOR, AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY

Mr. LEDBETTER. I will skip the majority of my statement so we can get right to what you want to talk about. I can see you are just itching to talk about where we go from here.

I want to make one point though from my testimony that I think is very interesting because it's a way to look at what the conservation R&D program has delivered for us in a little bit different way than we normally look at it. And the example that I want to point out is the technology that was developed through the program called low-emissivity glass. It is a high efficiency glass that reduces the amount of heat that can be radiated through a window. It's just an application of a super thin metallic coat to a window. It is transparent. You can hardly tell it's there. But it greatly reduces the amount of heat that can be radiated through a window.

And I have an example here. It illustrates the value of the technology in a little bit different way. It compares low-e glass technology with oil production from an offshore oil platform. I apologize for the small print. I'm sure it is very difficult to read from there, but I'm going to explain to you what the comparison is about.

On the left is a sputtering machine that applies the metallic coating to the glass. It costs about $8 million, and it can process around 20 million square feet of glass per year. And if you run that machine for its useful life, which is about 10 years, you produce a certain quantity of glass that is out there and saving energy. Over the life of that glass, once it has been sold, we can save about 36 million barrels of oil. This is from the single sputtering plant. We're selling plenty of these. And that's an $8 million investment to produce that.

On the right is the offshore oil platform. The exploration and development of setting up a platform that produces around 10,000 barrels per day can typically be around $250 million. And over the

10 year life of that platform, we can expect around 36 million barrels of production. So, these are equivalent ways of producing energy services for our economy of around 36 million barrels of oil equivalent. That is just I think a nice way to illustrate the worth of the conservation technology coming out of the program.

[The prepared statement of Mr. Ledbetter follows:]

TESTIMONY TO

THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

ON DOE ENERGY CONSERVATION PROGRAMS BUDGET

BY MARC LEDBETTER
AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY

May 18, 1988

Mr. Chairman and members of the Subcommittee, my name is Marc Ledbetter. I'm testifying on behalf of the American Council for an Energy-Efficient Economy (ACEEE), a private, non-profit organization that researches and disseminates information on energy efficiency. Thank you for inviting us to testify.

During the last 10 years, federal energy conservation R&D programs have been quietly turning out remarkable new energy efficiency technologies that have reduced oil imports, helped U.S. manufacturers compete with foreign energy efficiency products, and slashed U.S. energy expenses. Despite this record of success, funding for these programs has been sharply reduced during the 1980s. Federal conservation R&D spending in real dollars is now less than one third of what it was in 1980. We thus encourage you to recommend an increase in funding for DOE's conservation programs.

1. The DOE Conservation R&D Program has been highly successful.

The achievements of the DOE conservation R&D program are far to numerous to discuss here, but the following examples should provide an idea of how successful the program has been.

DOE's lighting research program helped develop the first solid state electronic ballasts in the U.S. These ballasts reduce energy consumption from fluorescent lights by 15-30% and allow adjustments to lighting levels to precisely match needs. When the research program was begun in 1976, none of the major ballast manufacturers showed any interest, nor did they respond to a request for proposals to cost share initial development. However, with the cooperation of several small manufacturers, DOE successfully developed the new ballasts. Electronic ballasts are now expected to grow from 1% of the market in 1985 to 50% in 1995. While DOE spent $2.7 million on this effort, savings to the U.S. economy are expected to reach $25 billion in the five years by which DOE advanced commercialization of the ballast -- an incredible 8,000 to 1 return on investment of federal dollars.

The federal R&D program also helped develop low-emissivity windows, which use a super thin, transparent metallic coating to block heat radiated through windows. The highly popular window

is expected to comprise 50% of the residential window market by 1995. In fact, Andersen Windows, which is the largest U.S. window manufacturer, claims that low-e windows already comprise more than 50% of their sales. Low-e windows are projected to reduce U.S. energy expenditures $13 billion in the five years by which commercialization of this product was advanced by federal involvement. This highly successful new product only cost the federal government $2 million.

DOE has advanced the commercialization of many other conservation technologies, designs, and procedures. A recent DOE report entitled Energy Conservation Program Success Stories lists about 30 new commercialized technologies developed through DOE conservation R&D programs, and dozens of other major program and technical successes.

Of course not all conservation research projects have been as successful as the two described above. However, the net benefits from just the two technologies listed above outweigh all the money appropriated since 1976 for the entire conservation R&D program by more than 15 to 1.

2. Conservation R&D can help improve the competitiveness of American industry.

An energy efficiency technology race is on among the industrial countries of the world, and federal support for development of new efficient technology is needed to keep U.S. industries in the race. Private U.S. companies cannot and will not do much of the needed research on their own -- the risks and costs are often too high.

American industry spends almost $90 billion per year on energy. Despite impressive gains in the last decade, it is far less energy efficient than most of its major foreign competitors. Improving the energy efficiency of American industry, especially energy-intensive industries, can make U.S. industry more competitive. New energy-efficient technologies developed or under development with DOE support can sharply reduce production costs. Strip steel casting, for example, can cut energy consumption in steel plants by 32% and sharply reduce capital requirements in new steel plants. Foam finishing for textiles substantially cuts energy used to finish textiles and doubles production rates. Impulse paper drying mechanically forces moisture out of paper, leaving less moisture that must be evaporated with energy-intensive processes. This process is expected to reduce energy consumption in a paper plant by 10% and sharply reduce fiber consumption.

Improving the energy efficiency of products sold by American industry is also an important means of making American industry more competitive. The vast array of industries that manufacture

energy consuming equipment, like the makers of residential appliances, commercial heating and cooling equipment, automobiles, and electric motors stand at the door of an enormous international market for advanced, energy efficient products. Japanese and American industry/government teams, for example, are competing to develop gas-fired residential heat pumps, which promise to be twice as efficient as the most efficient gas furnaces available today. Products like the solid state ballasts and low-e glass mentioned above have proven that a strong market exists for advanced, energy-efficient products.

3. Funding for the conservation R&D program needs to be stabilized.

Stable funding is highly important to the conservation R&D program, as it is to most any scientific research. The concern was recently addressed in a National Research Council report on DOE's conservation R&D planning process. The report stated,

> ...reduction in support for energy conservation R&D has had an adverse effect on research centers, particularly private sector contractors who may be cost sharing and who have made capital investments on the assumption of multi-year federal program commitments.
>
> Steps should be taken to stabilize the budgetary and contractual commitments to long-term research.
>
> Planning for Energy Conservation R&D
> National Research Council, 1986

Congress should take steps to stabilize funding and assure companies that are cost sharing in DOE research projects that Congress doesn't intend to sharply shift its funding priorities from year to year. One such step is to pass an authorization bill for conservation R&D. An authorization bill states a direction and an intention that is missing in appropriation bills. We support Senator Fowler's S. 1554.

4. The Alternative Budget for Energy Conservation recommends increases in funding similar to the increases recommended in S. 1554.

Because of the boost that federal energy conservation R&D programs can provide to U.S. industrial competitiveness and general economic strength, we urge this subcommittee to recommend increased funding for these programs. Our specific recommendations for increased funding are contained in the Alternative Budget for Energy Conservation, which was developed by dozens of organizations with expertise in conservation programs and technologies. (The list of organization that have endorsed the Budget is attached.) The Budget represents a sound,

realistic approach to federal support of conservation programs.

The recommendations for funding were built from the ground up. Experts in conservation R&D reviewed each individual subprogram for their importance to the overall federal conservation effort, and their funding needs. Needed funding increases as well as possible savings were identified and included in the recommendations. The resulting recommendations provide a minimum base level of support for existing programs.

The table below compares the FY 1988 appropriations, the FY 1989 and 1990 recommendations of S. 1554, and the FY 1989 recommendations of the Alternative Budget.

COMPARISON OF CONSERVATION R&D FUNDING
(in millions)

	FY 88 Approp.	FY 89 Alt Budget	FY 89 S. 1554	FY 90 S. 1554
Transportation	51.8	55.1	55.0	61.2
New Initiatives		5.4	3.2	2.0
Industry	33.1	32.6	36.5	44.0
New Initiatives		4.1	5.8	1.0
Buildings	34.6	47.2	42.7	53.8
New Initiatives		8.7	9.2	2.0
Multi-Sector	29.0	34.1	31.0	34.7
New Initiatives		2.5	2.0	1.0
Facilities	6.0	0	0	0
Policy & Management	1.7	2.4	1.7	1.7
Total	156.2	192.1	187.1	201.4

The Alternative Budget and S. 1554's FY 88 recommendations are similar. S. 1554's recommendations for FY 89 are higher than the Alternative Budget recommendations because the bill's FY 89 level is based on the assumption that the bill's FY 88 recommendations were going to be adopted, which didn't occur. We urge that the recommended funding levels in S. 1554 be adjusted to account for the lower-than-expected FY 88 appropriation and to more closely reflect the Alternative Budget recommendations.

The Alternative Budget does not contain recommendations for FY 1990 as S. 1554 does. Although we support the increases recommended for FY 1990, we recommend a larger increase. According to the Department's Multi-year Plan, the conservation

R&D program can easily put higher increases to good use, as can be seen in the following table.

FUNDING NEEDS IDENTIFIED IN DOE'S MULTI-YEAR PLAN

	FY 89	FY 90	FY 91
Transportation	93.4	96.8	97.7
Industry	53.3	51.9	50.3
Buildings	57.3	67.4	65.1
Multi-Sector	53.5	68.7	82.8
Total	257.5	284.8	295.9

5. The Alternative Budget contains recommendations for new research initiatives that exemplify what might be done with additional funding.

New Initiative on Industrialized Housing

Sweden supports a housing technology R&D program that supports a growing industry producing high-quality, super-insulated, factory-made houses. The program has helped factory homes expand from comprising 60% of the Swedish housing market in 1971 to 90% in 1983. Swedish funding for this program is approximately the same as U.S. government support for building R&D even though the Swedish housing market is 1/20 as large as the U.S. market. Swedish firms are now exporting these houses around the world. Some are even exported to the U.S. Japanese companies are also producing high-quality, factory-made houses that are being considered for export to the U.S.

Most homes in the United States, in comparison, are site built. Conservation efforts in these buildings have focused on improving building components, not on improving the construction and operation of the whole structure, an approach that can reduce energy demand by up to 60%. Thus home energy consumption remains high and expensive, and leaves the U.S. housing market vulnerable to foreign companies offering more energy-efficient factory housing.

We propose an industrialized housing program that would develop new technologies and designs that would reduce energy demand in factory-made homes to 50% of a comparable site-built house. This program would work closely with industry to develop computerized design and analysis tools for designers that treat houses as whole systems; analyze what elements of foreign industrial-built homes can be adapted to the U.S.; develop factory quality control procedures for testing the thermal integrity of sub-assemblies; analyze what new technologies in other industries can improve industrial housing, such as

engineered plastics, high strength adhesives, and flexible manufactured systems for automated assembly; and other tasks important to improving industrialized housing technology. We recommend $1.5 million for the first year of the five-year program, after which time the program will become self sufficient.

New Initiative on Advanced Windows for Automobiles

Another new initiative we recommend is advanced windows for automobiles. Recent styling changes in automobiles have increased the use of glass, which has resulted in greater internal heat gain from sunlight. In turn, automobile air conditioners are used more to compensate for the additional heat gain. Automobile fuel economy is consequently reduced, especially in hot climates. (About 5% of total fuel consumption in automobiles is attributable to air conditioning.) Recent advances in windows indicate there is significant potential for controlling heat gain in passenger vehicles. These advances include windows that 1) transmit only the visible portions of sunlight; 2) reject high angle sun but allow the driver to see through them, and 3) have switchable optical properties (like photochromic sunglasses). These technologies can reduce solar heat gain (which will allow downsizing of air conditioners) and substantially reduce the amount of fuel used by air conditioners. An aggressive Japanese effort to develop this technology will result in the commercial introduction of some advanced glazing features in 1989 car models.

An excellent opportunity exits to apply the results of a successful 10 year research investment in buildings glazing to automobile cooling problems. Proposed new research efforts include:

1) Development of a multi-year research plan with participation of industry.

2) Development of a simulation tool to predict auto performance with various glazing options.

3) Conducting basic materials research to develop the technology base for industry to develop advanced glazing materials. (This would build upon the related window research already supported by DOE for building applications.)

CONCLUSION

We recognize that the need to reduce the federal deficit makes it difficult to justify increased funding for any program. However, R&D is basic to the health of the U.S. economy and the ability of the U.S. to compete in international markets. Given

this nation's massive energy bill (approximately $370 billion annually), energy conservation's track record of helping to keep this bill down, and the enormous potential for further reductions in energy use, increased funding for energy conservation R&D is a wise investment for this country, even in times of tight federal budgets. We therefore encourage this subcommittee to work for increases in the conservation R&D program.

Senator WIRTH. And is that an example of the least cost approach?

Mr. LEDBETTER. I would consider it. It's $8 million versus $250 million.

Senator WIRTH. That's a stark polar example of what we're talking about. Is that right?

Mr. LEDBETTER. Right.

You asked about whether we had any ideas on new programs to get us some place. And I'm sorry. I didn't catch it exactly. You mentioned a 1.5 percent number.

Mr. FEDORUK. That's the number. That's the World Resources Institute estimate of what would be required to——

Mr. LEDBETTER. Oh, 1.5 percent——

Mr. FEDORUK. Per year.

Mr. LEDBETTER [continuing]. Increase in efficiency per year?

Mr. FEDORUK. Right.

Mr. LEDBETTER. All right. My organization is working with quite a number of people right now in putting together what we are calling an energy efficiency agenda that we hope is paid attention to by both the next administration and the next Congress. We are looking at quite a number of policy proposals from over 40 energy conservation energy experts around the country that have submitted proposals. We are going through an extensive review process in whittling this down to what we think are the most important of the policy measures. We are going to be releasing the document some time in June, and it is our intent through this combined program to come up with a very aggressive energy conservation policy.

And I can't in any way say that it's going to exactly improve our energy efficiency 1.5 percent per year, but we do mention a goal in there that is more aggressive. As a matter of fact, we talk about a U.S. goal of improving our efficiency of 2.5 percent per year, which is more in line with what the U.S. has done in recent years.

So, I don't know if you want to talk about that in any more detail, but we are putting together a comprehensive program.

Senator WIRTH. When will that be?

Mr. LEDBETTER. We're going to have the initial document out sometime in June, and then we're going to follow that up with a book-length document that will be ready sometime in the fall.

Dr. BLAIR. I've had a chance to think about your question. And I think my colleagues at the table are recounting a very laudable goal of pursuing energy efficiency and renewables. But I fear there is another dimension here that I mentioned only briefly perhaps in my statement. And that is you talked about the sense of urgency. Getting the goal of energy efficiency to ramp up at a faster rate I believe requires us to make energy efficiency accompany other benefits. For example, Marc's windows. If, for example, the windows could be easier to install perhaps than conventional windows, then perhaps construction folks would be more likely to adopt those windows not just for energy efficiency reasons, but for other reasons as well. And in this current environment, it is important that we recognize that there are lots of other kinds of competing pressures for whether or not we do energy efficiency investments or even renewables.

Mr. LEDBETTER. One quick point. I agree with Peter that there are significant problems with getting these technologies into the market and getting people to pay attention to them and use them. But this happens to be a particularly bad example of that point [laughter] because sales of low-e windows are exploding. Anderson Windows, which is the Nation's largest window manufacturer, now says that the——

Dr. BLAIR. That was a set-up. [Laughter.]

Mr. LEDBETTER [continuing]. Now says that low-e windows exceed 50 percent of their sales. And this technology was just introduced into the market in 1983. So, there are a couple of exceptions around.

Senator WIRTH. In the few minutes that remain, let me jump to global warming. And this goes to the question you and I were talking about earlier. How do you get people's attention up to this? It seems to me that we're having a very difficult time getting people to focus on energy overall. The price is down. The administration blows in our ear, tell us that the problem has gone away. All you have to do is deregulate and the problem is gone. Look at the success of that. You all have heard the whole load.

So, how do you get any sense of urgency up? It is very hard to do on energy grounds alone, and it seems to me there are two opportunities out there. One is the trade opportunity. If we don't shape up—you see the bar charts of U.S. energy use and how much of that is imported and what happens to the cost. And you know, that's one way to raise the issue, to piggyback on the trade deficit. That is still pretty obscure.

The other way is to see if you can piggyback on, say, the global warming issue which, it seems to me, there's the opportunity to do that. And then you say, well, how can you get the global warming issue out there. We say, okay, what has been like global warming. Well, maybe the chlorofluorocarbons issue has been like global warming. And how did that get in the headlines? You know, it took Secretary Hodel to get it out there with dark glasses and hats and all that kind of good stuff as a way of getting at the CFC issue. No, really. Suddenly people got focused. They came from a number of other issues. But that did it.

Now, how much awareness do you suppose—if we want to piggyback, and that's something that ought to be thought about and that we ought to be recommending to a new administration, whether it's Bush or Dukakis administration. Is it possible, do you think, to do that?

Mr. SKLAR. Yes. And I think I'd like to answer that. When the Congress was discussing clean coal technology, our industries went to them and said, well, we have a part to play in that. And you ought to put in a little percentage to see how you incorporate renewables into either like wood, coal, coal firing, for instance, which we recommend, or in fact displacement of coal directly where that makes economic sense. And I think in both the production side of this of having to make conventional energy more environmentally usable or environmental legislation which places controls, I think what we need to do is every time that kind of legislation goes through here, one of the senior members of this subcommittee adding some amendments in this regard on least cost planning,

energy planning, and energy conservation and renewables. We must have that.

Senator WIRTH. What can be done this year?

Mr. SKLAR. I don't know of a track on those pieces of legislation this year. I think we may have missed some opportunity. I don't know.

Mr. LEDBETTER. I have an idea. My idea is in the area of acid rain legislation.

Our organization and Nick's organization produced a study about a year and a half ago that looked at the kinds of cost savings you can get by incorporating an aggressive energy conservation program into an acid rain control program. Benefits come out of it in two ways. One, you avoid fossil fuel consumption in the first place so you don't have to clean up that portion of your emissions. And two, you generate such enormous economic savings in a utility system with conservation programs that you can end up not only completely paying for all your retrofitted emissions controls, but you have lots of money left over.

And we've talked to people on the committees up here that are dealing with acid rain legislation and have had moderate success. The Environment Committee up here put some language in the acid rain bill.

Senator WIRTH. It doesn't look like we're going to get an acid rain bill this year.

Mr. LEDBETTER. I'm not the expert on that. I don't follow that legislation that closely. But I occasionally talk to Hill staffers who claim that there is a chance. So, I'm not the best judge of it.

But I would like consideration of energy efficiency put into that legislation. I think it is a nice way to handle it.

Mr. FEDORUK. I think there are some other factors. This is the appropriate committee to say it I suppose, but I think passing the Fowler bill would be an important signal in that direction.

Senator WIRTH. Passing the?

Mr. FEDORUK. Fowler bill. The multiyear R&D funding bill that has been recommended by Senator Fowler I think is an important step to saying that we need a multiyear commitment, that you can't just sort of go from year to year and expect to deal with problems of this magnitude.

I think another issue that we need to take a closer look at is that we have in general tended to talk about energy efficiency, and I think global warming raises another issue. Maybe we need to talk about carbon efficiency and what technologies can we use that will significantly either increase the productivity of the carbon fuels that we use or replace them. And I think that that could be an important measure to add to the least cost analysis.

Senator FOWLER. Gentlemen, we thank you very much.

The Chairman of the committee, Senator Johnston, is increasingly interested and concerned about the area of global warming. So many pieces of what this committee does vectors in on that. And it seems to me that may be a central way in which we can get at a lot of the concerns that you all have and have expressed so well.

We look forward to working with all of you. We thank you very much for being here today. We appreciate your comments and work. Thank you very much.

[Whereupon, at 3:24 p.m., the subcommittee was adjourned.]

APPENDIX

Additional Material Submitted for the Record

Statement of the Institute of Electrical and Electronics Engineerings, Inc.
On the Department of Energy
Photovoltaics, Electric Energy Systems and Energy Storage Programs
before the Subcommittee on Energy Research and Development
Senate Committee on Energy and Natural Resources

The IEEE is the world's largest engineering society, with nearly 295,000 members worldwide, 232,000 of whom live and work in the United States. Approximately 82% of our membership is employed in industry, 8% in academic institutions, and 10% in the various government laboratories and agencies. The Energy Committee itself has representatives from 32 different technical societies (within the Institute) and 6 different geographical regions. The Committee is vested with the authority to develop the Institute's energy policy and, once that policy is adopted by the Institute, we are one of the major mechanisms by which the policy is voiced in public.

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INTRODUCTION

It is the view of the IEEE that the current national energy situation demands some significant changes in the direction of energy technology. We can no longer plan our energy future under the assumption of secure, abundant, and inexpensive supplies of the fossil fuels we have become so accustomed to for the vast majority of our energy. The history of oil price volatility and supply disruptions, our current dependence on imported energy supplies, the skyrocketing costs of electric utilities, and the growing concern over the environment have focused us to rethink the approach we should take in planning our long-term energy future. We need to expand our energy options through the continued development of new technologies that rely on abundant resources, providing stable prices and reliable power.

My comments today will focus on photovoltaics and energy storage and distribution technologies, areas that can, with continued development commitment, dramatically improve the availability, efficiency, and cost of future electricity. Photovoltaic applications are already proving to be important contributors to remote power sources, and several electric utilities are currently incorporating photovoltaics into their grid network, while an increasing number of other utilities are investigating such applications for future needs. The development of electric storage and distrubution technologies will facilitate the integration of renewable energy technolgies into the utility grid as well as improve overall reliability and efficiency of the electric power system. Both PV and ESD technologies warrant strong research support from the government for the sake of our energy future. I will first address photovoltaics technologies.

PHOTOVOLTAICS

Photovoltaics has proven to be a cost-effective option in many current energy applications, and in the long-term shows potential as a viable alternative to depletable fuels in utility-generated electric power. Significant progress has been made in advancing photovoltaic technology through government-supported research and a high level of industry involvement. Cell efficiencies and costs have improved dramatically over the past decade. The research to date has provided the basis for determining the technical potential of photovoltaic technology. Given sustained research efforts, photovoltaics can, in the long-term, become a competitive energy option. Continued improvement in cost effectiveness is expected to result in economic additions to the national power grid before the year 2000.

Because photovoltaic energy systems rely on sunlight as a fuel for energy conversion, the resource base is infinite and does not present the potential problems associated with fuel supply shortages. A shift to photovoltaic power generation in the 21st century would relieve the pressure on the price of fossil fuels and help preserve this valuable but exhaustible natural resource. Silicon constitutes 25% of the earth's crust and is available at a very low cost in its metallurgical grade form.

Photovoltaic technology has progressed in 30 years from a laboratory curiosity through expensive satellite uses to the current application of small scale and remote power needs. Approximately 70 utilities are involved in photvoltaics in the U.S. through research, system evaluations, power purchases, or actual photovoltaic installations. Photovoltaics has reached a level of cost-effectiveness that is resulting in an explosion of applications. Several demonstration projects in developing countries have proven the importance of photovoltaics in these areas. Rural electrification projects in parts of Africa, Asia, South America and some island countries are providing power for refrigerating medical supplies, water pumping and household lighting. Several grid-connected bulk power photovoltaic systems are currently in operation. The Hesperia power plant, a 1-MW facility, supplies power to Southern California Edison; the Carissa Plains facility, a 6.5-MV system, uses improved technology and has a power sales agreement with Pacific Gas and Electric. PG&E is promoting "Photovoltaics for Utility Scale Applications" (PVUSA) to advance utility photovoltaic systems.

One of the major concerns in developing a cost-effective module will be the investigation of the effects of module exposure to environmental elements as they affect life expectancy. In addition, research in solar radiation will provide the data needed to ensure that photovoltaic devices are developed to achieve optimum performance over a wide range of outdoor conditions. Photovoltaics will not reach its maximum usefulness without the concurrent development of utility useful economic storage. Research in storage technologies, which I will address in the next part of my testimony, are necessary, that they may augment today's physical technologies. The long-term performance, reliability, and operational costs of photovoltaic systems can be verified only by evaluating operating systems. Initiatives in the private sector to utilize the technology will assist in building the field-performance data base for technology evaluation.

The IEEE's recommendations for furthering photovoltaics technology centers around the combined efforts of federal support and private sector research efforts. A continued commitment to research and development in photovoltaics is essential to the advancement of the technology that will allow photovoltaic systems to be competitive in the energy market. The photovoltaic industry has a strong record of R&D investment, which has contributed to the impressive advancements in the technology. Industry participation should continue to be encouraged. Several photovoltaic applications are currently cost effective. The private sector should consider, whenever possible, photovoltaic systems along with all other options. One of the most promising near-term markets for photovoltaics is remote applications in developing countries. International market initiatives, such as those taken by the Committee on Renewable Energy Commerce and Trade should continue to be encouraged.

In order to expedite the integration of photovoltaic systems in the energy market, efforts should be made to increase public awareness and acceptance of photovoltaic energy through information dissemination. The federal government should play a role in the support of research and development activity through the point of technology transfer. The IEEE urges the federal government to expand its R&D program in photovoltaics on a long-term basis in order to lay the

foundation for a photovoltaics utility-scale power industry in the 21st century. The photovoltaic industry has committed extensive time and funds in research and development, and this should be a sign to the government that there is real dedication to the viability of the technology, and as such, warrants its support.

ELECTRIC ENERGY SYSTEMS AND ENERGY STORAGE

The IEEE has an official Institute Position Paper on "The Role of Electricity in the U.S. Economy" which has emphasized the fundamental importance of energy availability to the welfare and economic health of society. Our position recommends an increased role for electricity in the nation's energy economy and calls for increased support of research and development programs to improve electric power systems' efficiency and reliability, as well as to provide advanced energy conversion technologies.

The IEEE has consistently supported the Electric Energy Systems (EES) and the Energy Storage (ES) Program in testimony before Congressional Committees having budget oversight responsibilities. We strongly support the continuation of these programs at a budget level that will enable meaningful research to be undertaken. We endorse the Administration's additions of high temperature superconductivity research to these areas. However, we are disappointed in the continuing reductions in research funding for the more traditional research thrusts of both the EES and the ES programs.

A long-term commitment to research in EES and ES, both complex and critical areas, is essential. Government and industry agree that research continuity is important, but maintaining such continuity is becoming increasingly difficult, when budget levels are proposed to be so substantially reduced each year. Research does not have immediate paybacks. Technological advancements require hard, patient and deliberate efforts for extended periods of time. Further, to advance technology in this complex world requires a significant and continuing investment in human and capital resources. Research should not be subject to peaks and valleys in funding levels, because the quality of that research will suffer. Because electric utilities revere the importance of safety and reliability in electricity supply, new technologies must show great promise in order to be developed and accepted by the utility industry. Sharing the risk on these projects as government and industry must, is a particularly difficult problem when budgets undergo dramatic annual changes.

We have reviewed the current program plan and are concerned that requested funding levels will severely curtail important research efforts much more than the overall 12% reduction in the bottom line would imply. It would seem questionable for the Department of Energy to again propose substantial reductions in the traditional Electric Energy Systems program thrusts such as reliability at the same time that the Federal Energy Regulatory Commission is taking steps to restructure the electric power industry in ways that will greatly complicate utility system interfaces and the determinants of individual system reliabilities.

The EES and ES research programs are designed with a knowledge of the energy requirements of the United States and the mandated rules of funding research given by the Department of Energy. The guidelines for what is appropriate for active government support are well articulated. The government involvement is principally focused on areas that are crucial to the economic well-being and security of the nation and are high-risk and long-term programs. These programs cannot or will not be attempted by non-government entities. Industry, principally through the Electric Power Research Institute (EPRI), places emphasis on the solution of near-term problems. Manufacturers generally have not supported long-range, high-risk research, because they require a return on their research investments within five years or less. Tax structures, foreign government-supported competition, and the growing cost-price squeeze all tend to limit manufacturer long-term research support. The research that does exist is directed toward improvement of existing lines of equipment in which there is already a heavy investment. Utilities' support of research is restricted not only by financial conditions which are increasingly severe in some regions of the country, but also by regulatory and rate based pressures.

IEEE is concerned that the current adequacy of energy supplies belies the fact that this is a transient condition and this "glut" of supply could end in the early 1990's. The Energy Committee of IEEE believes this to be so and recent articles in the popular and business press report concurring expert opinion. Over the past few years there has been a significant attrition in both government and private industry technical leadership in the EES and ES programs due to the severe reductions in research funding. Meaningful and successful research will only result when there is a continuum of experienced technical expertise available to do the research and educate and train new manpower. As research dollars dwindle the research personnel will seek other career opportunities if continuity of funding is unreliable. This is a serious implication of declining research monies.

In summary, one must not lose sight of the hard facts of research. From the inception of the research program to commercial viability, a project may take 10-15 years to complete. We must be working today for systems to be available for commercial use in the 21st century. The Photovoltaics, Electric Energy Systems and the Energy Storage Programs are dedicated to important and critical research. It will require long lead times and continuity of funding through the whole R&D cycle to achieve success. Research activities that can provide benefits to public health, national security, and the economic viability of our electricity production and electric utility manufacturing industry are deserving of more serious consideration for government funding in FY 1989.

TESTIMONY OF

AMERICAN WIND ENERGY ASSOCIATION

TO THE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

May 18, 1988

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AWEA is a trade association which represents the manufacturers of wind electric turbines and components and related companies. About 150 companies are members of AWEA. While most are small businesses, a few utilities, such as Pacific Gas & Electric Co. and Hawaiian Electric Renewable Systems are also among our members.

Our testimony basically emphasizes three points:

1. Despite a series of major setbacks in recent years, such as the decision of the Congress to allow renewable energy tax incentives to expire in 1985, and its further decision to cut the wind energy research budget by nearly 50% last year -- the American wind energy industry is continuing to develop an increasingly mature energy-producing technology.

2. The progress of our industry cannot be sustained, however, without a continued serious commitment to the development of wind energy technology by the federal government. While we are slashing our research budget, other countries are launching aggressive joint government-industry programs.

3. Accordingly, we propose not only to maintain the current wind energy research program without further cuts, but in addition to fund a Wind Technology Leadership Initiative to develop a new advanced intermediate-size wind turbine. Such a turbine will allow American industry to remain competitive in the new and growing international market for power supply which we see developing in the 1990's.

We would like to elaborate on these points.

1. Despite a a series of major setbacks in recent years, such as the decision of the Congress to allow renewable energy tax incentives to expire in 1985, and its further decision to cut the wind energy research budget by nearly 50% last year -- the American wind energy industry is continuing to develop an increasingly mature energy-producing technology.

Our industry absorbed a major blow in 1986 when the Congress decided not only to allow the 15% renewable energy investment tax credit to expire, but also at the same time to repeal the basic 10% investment tax credit.

This decision probably would have destroyed the wind energy industry in the United States if the economics of the technology had been less promising. Like other renewable energy technologies, wind energy has a high initial capital cost compared to conventional energy technologies, and the investment credits were an ideal incentive.

As it is, the pace of wind energy's growth slowed sharply. The total capacity of new wind turbines installed in 1986 dropped to about 200 megawatts (MW) from approximately 500 MW in 1985, a 60% reduction after four straight years of exponential growth. In 1987, about 150 MW were installed, for a further 25% drop.

Nevertheless, our Association continues to see indications that wind energy technology is continuing to mature:

- Energy production per kilowatt (kW) of installed capacity rose from 660 kilowatt-hours (kWh) in 1985 to 920 kWh in 1986, an increase of nearly 40%, and to an estimated 1,100 kWh in 1987 for a further 20% boost.

- 1987 marked our sixth consecutive year of increased capacity and increased productivity, which combined to bring about another massive jump in total wind electric power production. Total windfarm power output rose from 670 million kWh in 1985 to 1.2 billion kWh in 1986 and 1.7 billion kWh in 1987 -- a 150% increase in just the last two years.

- About 3 million barrels of oil would have had to be burned to produce the same amount of electricity as the windfarms did in 1987, and by year's end, the cumulative savings from wind totalled nearly 7 million barrels.

- While the indicators of production climbed, wind energy's installed costs have continued to drop steadily (see attachment A). The turnkey installed cost of a windfarm at the end of 1987 was a <u>little less than one-third what it was in 1981</u>.

- Since the "fuel" for a wind turbine is free, the operating costs (Operations & Maintenance costs plus fuel) for a wind power plant remain well below those for any conventional energy source.

- The total levelized cost of power from windfarms, at 7-8 cents per kilowatt-hour, has fallen below the cost of power from new California nuclear power plants, which is in the neighborhood of 11 cents per kilowatt-hour.

In short, after a decade of development and learning experience, wind energy continues today to look like one of the outstanding winners among the new energy sources which the Science and Technology Committee identified for targeting federal research efforts in 1974.

That being the case, it is difficult to understand why the Congress continues to cut the wind energy research budget. While we understand the need for budget control, our feeling is that scarce resources should be directed toward the areas with the greatest potential for payoff, and wind energy has clearly shown major promise not only in the laboratory, but in the real world.

It is important to understand that wind energy's forward progress has not always been smooth. Harnessing the wind has proven to be a surprisingly difficult technical challenge.

The force which the wind creates on an object in its path is a function of the cube of the wind speed, so that the forces working on a wind turbine increase geometrically as the wind rises. Also, the wind is often very turbulent, changing direction and speed quite rapidly. For example, a doubling in speed and change in direction of 45 degrees in less than one second is not uncommon.

This high variability means that a wind turbine operates in a very difficult environment which was not originally well understood.

It was originally thought that the aerodynamics of helicopter blades and airplane propellers would be readily applicable to wind systems. That has not proven to be the case. Wind turbines are different and require very different airfoil shapes.

Early analyses also assumed, for lack of better information, that the wind's flow would be relatively smooth. That, too, was mistaken. The physical stresses which a wind turbine undergoes in actual operation were often several orders of magnitude greater than those predicted by engineers.

And finally, fatigue remains one of the most difficult and elusive problems in wind turbine design. Wood-epoxy laminates and composites are the materials of choice for wind machine blades, and little useful fatigue information is available even

today for these materials.

2. The progress of our industry cannot be sustained, however, without a continued serious commitment to the development of wind energy technology by the federal government. While we are slashing our research budget, other countries are launching aggressive joint government-industry programs.

Despite the technological and commercial progress our industry has made, its survival today and in the near term is threatened by a series of unfavorable federal policy decisions.

Federal government support for wind energy has been dramatically reduced. The energy investment credit and the basic investment credit totalled approximately $200 million in support during calendar 1985, their last year of existence -- an amount more than 20 times last year's federal wind research and development (R&D) budget. Thus wind energy is unique among the renewable energy industries in having lost over 95% of the overall share of the federal budget which it held in 1985.

In addition, the Congress has also sharply cut the wind research budget, from nearly $25 million as late as FY 1986 to just $8.5 million last year -- a cut of two-thirds in just two years!

And at the same time as the U.S. has become the only major industrial country in the world to reduce spending on wind energy, our foreign competitors are forging ahead.

The results are clear. Over the last seven years, the American wind turbine industry has gone from making 100% of the product sold in the U.S. market to 30% today (see Attachment B).

Our Association has steadfastly opposed protectionism. We believe that open commercial competition in the world market serves everyone's best interests, and that the key to commercial competition is making a better product.

But the manufacturers of other countries enjoy an open and productive relationship with their governments, and with our government making drastic cutbacks in its commitment, the battle is becoming unequal:

- This year, for the first time, West Germany will spend more on wind energy research (US$10.2 million) than the United States (see Attachment C.)

- This year, for the first time, the Netherlands will spend more on wind energy subsidies (US$9.7 million) than the United States.

- Manufacturers in both West Germany and the Netherlands can

count on additional subsidies from the European Community, which will also spend more in the coming year than the U.S. on wind energy.

- Members of a U.S. wind energy trade mission to India, which returned just three weeks ago, were dismayed to find upon their arrival that the government of Denmark, a country with fewer people than the state of Virginia, has agreed to give the Indians $25 million in aid provided the funds are spent on Danish renewable energy equipment. This compares with the U.S. wind research budget of just $8.5 million.

- While major U.S. corporations such as Boeing, Alcoa, General Electric, Grumman, and Bendix have pulled out of wind energy over the last seven years, foreign industrial giants such as Mitsubishi Heavy Industries, Messerschmitt, British Aerospace, and MAN have moved in.

We are currently in an era of low energy prices and, in many regions of this country, perceived adequate generating capacity through the early 1990's. However, oil pricing is largely politically controlled by non-U.S. interests, making it a potential national vulnerability. Also, despite utilities' projections of an acceptable balance between existing capacity and future load growth, there are indications that demand is increasing faster than has been projected. Utilities generally are not adding or planning new capacity. Further, because of significant recent financial exposure in the construction of nuclear generating capacity and a more-questioning regulatory environment, utilities may be said to be averse to adding capacity.

This situation indicates the potential for a significant domestic and export market for grid-connected wind power generation systems beginning in the period 1993 through 1995. Based upon the California experience in the first part of this decade and market projections by T. F. Jaras for the period through 1991, the size of this market is estimated to be slowly increasing to a level of about $300 million per year. Analysts at R. Lynette and Associates have made total market projections for the period 1994 through the year 2000. Their projections indicate a total market growing from approximately $1.0 billion per year in 1994 to a range of $3 billion to $6 billion per year by the year 2000. Depending upon the energy price scenario chosen, other observers estimate that, over the five-year period beginning in 1995, the total size of this market to be in excess of $2 billion of which at least half would be export sales.

3. Accordingly, we propose not only to maintain the current wind energy research program without further cuts, but in addition to fund a Wind Technology Leadership Initiative to develop a new advanced intermediate-size wind turbine. Such a turbine will

allow American industry to remain competitive in the new and growing international market for power supply which we see developing in the 1990's.

The Initiative, which consists of developing the turbine and field-testing it in two major configurations, would last for four years, beginning in FY 1989 and extending through FY 1992, and would be added to the continuing research activities of the federal R&D program.

The concept of the Initiative is based upon extensive private sector experience gained over the last eight years with thousands of wind turbine energy generation systems in California.

California windfarms have successfully proven the feasibility of large-scale wind electric generation and have also served as a massive proving ground upon which rapid evolution of the technology has taken place. At the same time, the California experience makes it clear that some major technical challenges must be met before the U.S. wind energy industry can successfully compete either with conventional energy sources in the domestic power market or with foreign wind turbine manufacturers overseas:

-- The cost of energy from wind turbines, while it has come down steadily, is still too high;

-- The characteristics of the power they produce are not sufficiently attractive to electric utilities; and

-- The technical superiority of U.S. equipment has been countered effectively by experienced foreign exporters offering turbines which initially appeared more reliable.

The Wind Turbine Leadership Initiative will respond to these challenges, building on:

-- Experience of U.S. wind energy companies in the California proving ground, which is by far the world's largest and most extensive;

-- Scientific knowledge and results which have been obtained and which continue to flow from the U.S. federal wind energy research program; and

-- Major advances in system design.

The system design advances flow from the previously-cited federal and private sector experience and, in addition, integrate advances in:

-- Semiconductor technology;

-- The technology of circuits for processing large quantities of electric power; and

-- New options for wind turbine control systems.

The Initiative consists of three parts:

1) Development of a third-generation, utility-optimized wind turbine system for interconnection with utility grids;

2) System integration testing of the system in the context of a large utility generation and distribution system; and

3) System integration testing of the system in the context of a small utility generation and distribution system.

Funding required for the Initiative amounts to $16 million during its four years, over and above funds required for the balance of the federal wind energy program, with the largest part ($7.5 million) coming in the second year, FY 1990.

As energy needs increase in this country and abroad, as the U.S. becomes increasingly dependent upon energy imports, and as energy costs increase above the recent low values, the Initiative will provide the following benefits in return for this investment:

1) It will build on and help to expand the current U.S. lead in wind-driven power generation technology, a promising international market for the 1990's and beyond;

2) It will lead to export sales of equipment and services, aiding the balance of trade, reversing the recent flow into this country of non-U.S. manufactured wind power equipment, and providing increased domestic manufacturing and equipment service jobs;

3) It will provide a mature, fully-proven, cost-competitive renewable energy generation technology for this country, a renewable technology proven capable of supplying significant quantities of energy to utility transmission and distribution grids;

4) It will lead to greater domestic use of wind energy, which will reduce atmospheric pollution, improve national security, and help diversify U.S. energy supplies.

We have a detailed description of the proposed Initiative and a series of other detailed recommendations on the wind energy research budget which we will be presenting to the Subcommittee staff for review.

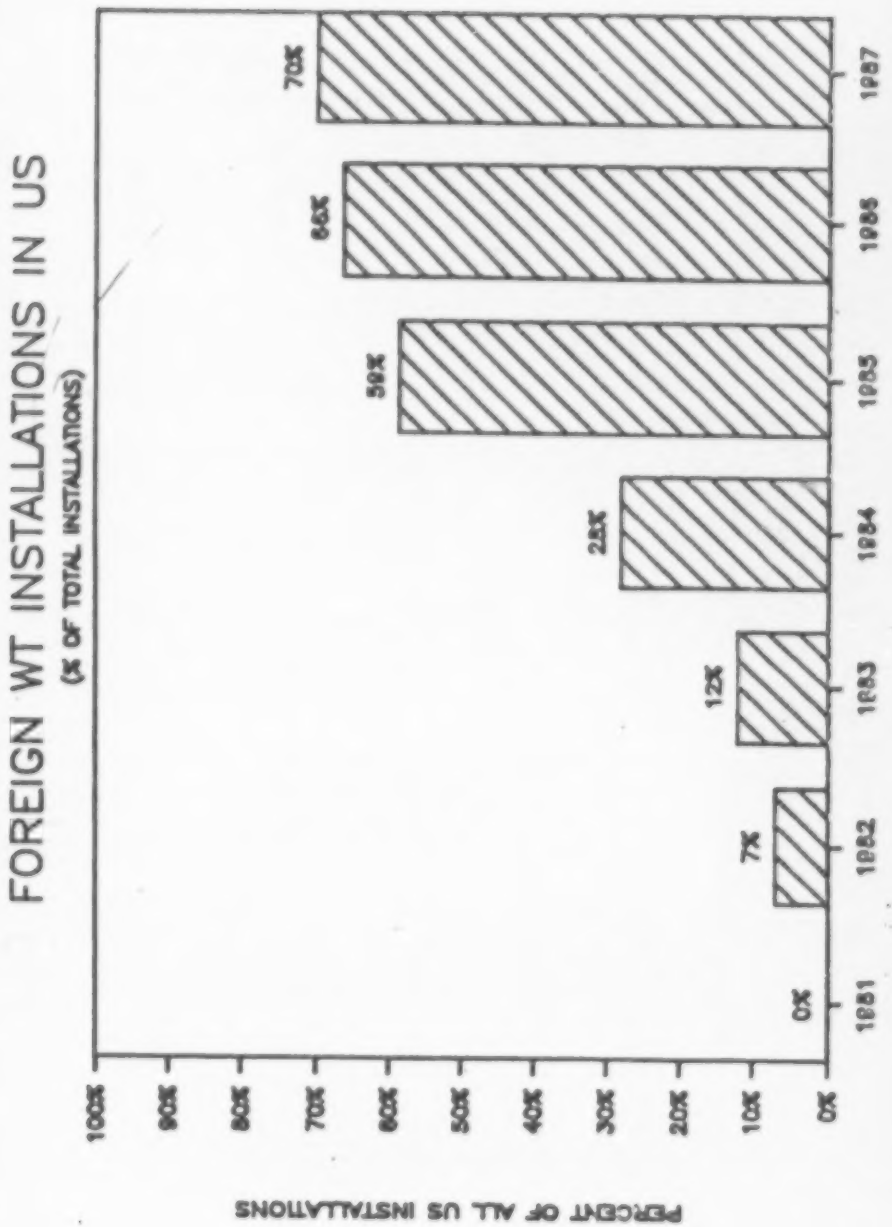
While we call for some changes in emphasis in the federal R&D program, our main recommendations are two: first, that the overall budget for ongoing research not be reduced below last year's level of $8.5 million, which is already well below what we consider a minimum realistic level of effort; and second, that an

additional $4.3 million be allocated for the first year of the Wind Technology Leadership Initiative.

Again, we thank you for the opportunity to present our views.

ATTACHMENT A

ATTACHMENT B



ATTACHMENT C

WIND ENERGY FUNDING IN WEST GERMANY

Table 1: Wind Energy Projects since 1975; Costs in mill. DM

Year	BMFT Contributions	Total Costs
1975	0.1	0.1
1976	0.2	0.2
1977	4.1	5.1
1978	9.3	11.5
1979	17.8	18.9
1980	32.4	33.9
1981	42.2	43.8
1982	31.0	32.3
1983	16.0	17.9
1984	8.9	10.9
1985	10.2	11.7
1986	12.1	16.6
1987	17.2	27.4

Table 3 : Contributions for Wind Energy

Category	mill. DM	No. of projects
Large scale WECS	99	4
Medium-sized WECS	46	3
Small WECS	38	27
Other projects	22	26
Windpower in the Third World	20	< 10 *

* not all purely wind projects

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UNITED STATES SENATE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

TESTIMONY OF THE

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ON

FUNDING FOR DEPARTMENT OF ENERGY CONSERVATION PROGRAMS FOR FY 1989

May 18, 1988

TESTIMONY OF THE

NATIONAL ASSOCATION OF REGULATORY UTILITY COMMISSIONERS

IN SUPPORT OF THE ALTERNATIVE CONSERVATION BUDGET FOR FY 1989

This testimony is submitted for the record by the National Association of Regulatory Utility Commissioners (NARUC) with respect to May 18 hearings on the FY 1989 DOE budget for energy conservation programs. The NARUC is a non-profit, quasi-governmental Association founded in 1889 whose members are the state commissions responsible for the regulation of our nation's utilities and carriers. In this capacity, we are responsible for ensuring that consumers of electricity and natural gas nationwide are provided with the highest quality, lowest cost utility service possible.

Based upon our experience in this regard we have become convinced that the public interest is best served when energy planning takes into consideration the broad spectrum of options available for serving consumers' energy needs. It is with this in mind that urge your support for the Alternative Conservation Budget for FY 1989.

Those of us who regulate utilities at the state level have a vital interest in the federal government's funding of energy conservation programs. These federal programs have helped millions of consumers to minimize their utility bills and have spurred the development of many new energy-saving technologies by

U.S. industries. Due in part to the wise investments made by the federal government over the past 15 years, energy efficiency has become the fastest growing source for meeting future energy needs in the U.S. economy, and the most economical.

Unfortunately, our nation's continued progress toward improving energy efficiency is now threatened. It is threatened by a short-sighted proposal by the Administration to cut federal funding for energy conservation in FY 1989 to barely one-fourth of the current fiscal year's levels -- even though these programs have already been cut to the bone.

In our view, it would be difficult to find a better place to invest federal funds than in energy conservation. When low-income citizens weatherstrip and insulate their homes with the help of the federal Weatherization Assistance Program (WAP), for instance, the resulting savings is repeated year after year, and it reduces their need for other assistance programs. Another federal program offers badly needed conservation assistance to local schools and hospitals.

Similarly, federally funded research and development has enabled U.S. industries to develop numerous energy-saving innovations which are cutting energy costs across the country by billions of dollars. One example of the impressive track record of federal expenditures on energy conservation R&D, according to

the American Council for an Energy-Efficient Economy (ACEEE), is that a $5-million R&D expenditure on energy-efficient lighting and windows accelerated the development of these technologies by five years. These new technologies will ultimately save consumers $36 billion that they would have spent on energy bills had this R&D program not existed -- a return of 7000 to 1.

Indeed, the energy-saving investments we have made since the Arab Oil Embargo 15 years ago are saving our country $130 billion a year in energy bills, according to ACEEE. Given the enormous contributions energy efficiency improvements make to our nation's economy, I find it astonishing that even before the cuts proposed by the Administration, less than 3 percent of DOE's budget is spent on energy conservation.

To look at it another way, for every $1000 our nation spends on energy, the government invests only 42 cents in R&D to explore ways to use energy more efficiently. When we consider the potential economic payoffs from energy efficiency improvements, we could easily justify spending ten times that much on energy conservation R&D. Yet the Administration wants to cut that figure even further, to just 23 cents.

For example, whereas the U.S. spends approximately $440 billion annually on energy needs, we are presently suggesting that some $440 million be spent on efforts to reduce that amount.

This is roughly analogous to investing $440 in conservation improvements on a $440,000 home. Given the demonstrated return on such investments, we would argue that, with respect to national energy policy, the federal investment in conservation should more appropriately be something approaching 10 percent of the U.S. energy bill, or $4.4 billion.

Because of the the vital importance of adequate federal support for energy conservation programs, NARUC has joined with some 27 other national organizations in proposing an Alternative Budget for Energy Conservation for FY 1989. The proposal recommends FY '89 federal expenditures of $439 million on energy conservation programs, about 19 percent above FY 1988 levels.

This alternative budget represents a modest proposal for restoring balance in the federal energy budget. We view it as a critical level of maintenance and, ideally, a first step toward substantially higher levels of funding for energy conservation. We strongly hold that much higher levels are clearly justified by their contribution to sound energy and economic policy.

The alternative budget for energy conservation R&D, totaling approximately $192 million, includes proposals for a number of promising new R&D initiatives in energy efficiency. These include R&D on factory-made housing, desiccant cooling research, and commercial retrofits (using federal buildings as test

facilities). Our proposed budget also recommends modification or elimination of some existing R&D programs in order to keep this program cost-effective and reasonable with respect to current fiscal realities.

Within DOE's R&D budget, NARUC is especially concerned about maintaining funding for DOE's Least-Cost Utility Planning (LCUP) program at the $2-million level. This innovative "technical transfer" program assists utilities and regulators in developing new institutional frameworks for incorporating energy conservation potentials in the utility planning process. The program helps to bring new energy conservation technologies into millions of homes, businesses and public buildings across the country.

We also urge the Congress to remove the restrictions which earmark more than one-third of DOE's LCUP funds for rural utilities in the Northeast. We believe that all parts of the nation should have an equal opportunity to participate in the LCUP program.

In creating innovative programs such as LCUP, Congress has recognized that in a society where there are many institutional barriers to saving energy, hardware alone does not deliver energy savings. The LCUP program is designed to help utilities and regulators to correct some of the market failures which make it

easier to waste energy than to save it. With assistance from DOE's least-cost planning program, utility regulators in more than half the states are implementing utility planning procedures which consider energy conservation on an equal basis with energy supply options.

We would also note that the federal investment in least-cost planning will itself prove to be extraordinarily cost effective. At present, DOE has invested approximately $3.5 million in the LCUP program. If, through this program, we are able to avoid, through conservation and load management, the construction of one new powerplant for one year, the return is potentially well over $100 million. And with respect to supply additions, least-cost planning would favor plants with lower life-cycle costs, thereby ensuring that plants which are built are the right ones for the job.

As conservation efforts across the nation move forward in the coming years, we will continue to monitor the exciting and promising federal R&D projects which are currently underway. And through our least-cost planning process, we will endeavor to quickly translate new energy savings opportunities into lower energy costs to consumers, while attempting to maximize the incentive for innovation and opportunity for reward for the utilities themselves.

Unfortunately, the effectiveness of federal energy conservation programs has already been compromised by the enormous cuts these programs have suffered since 1981. The additional 74-percent cut proposed by the Administration for FY 1989 would effectively dismantle these federal programs altogether. We urge Congress instead to begin the process of restoring an equitable and efficient balance in the federal budget. Perhaps Congress should apply its own least-cost test and allocate funds to the energy technologies which promise to meet consumers' energy needs at the lowest cost. Under such a scheme, I am confident that energy conservation would command a much larger share of the DOE budget.

Energy conservation is by far the lowest cost means of meeting our nation's future energy needs. The federal government's energy conservation programs have an impressive track record for delivering energy saving opportunities which benefit our entire country. NARUC urges the Congress to adopt the programs and funding levels for energy conservation which we have proposed in the Alternative Budget for Energy Conservation for FY 1989.

# # #

TESTIMONY FOR THE RECORD

United States Senate

Committee on Energy and Natural Resources
Subcommittee on Energy Research and Development

A.J. Appleby
Professor and Director
Center for Electrochemical Systems and Hydrogen Research
Texas A&M University, College Station, TX 77843

Subject: Hydrogen Fuel and the Greenhouse Effect

The environmental and fossil-fuel resource depletion concerns of the early 1970s led to the suggestion that hydrogen might be a universal fuel, or more accurately, an energy vector or transporter in the context of the so-called "hydrogen economy" (1). It was suggested that the hydrogen could be manufactured from water using solar or nuclear energy, and used for all those applications where storable energy is necessary, particularly in transportation. If the future economy would involve energy movement over long distances, e.g., from remote nuclear sites, large hydro stations, desert areas of high insolation or from remote microwave collectors from solar space platforms, then hydrogen was considered to be less expensive to transport by pipeline than electricity via conventional high-tension cables. The hydrogen could be transformed on-site into useful work at an efficiency approaching 60% using the most efficient energy converter known, the hydrogen fuel cell. Since the only oxidation product would be water vapor (which would in effect be recycled), the whole concept would be entirely non-polluting.

More recent developments have led to modifications of this concept. These involve both changes in technology and evidence that atmospheric warm-up and climate change, due to the carbon dioxide "greenhouse effect," resulting from the direct-burning fossil fuel, may be upon us much sooner than was thought in 1972. Non-fossil hydrogen, produced as outlined above would completely avoid the greenhouse effect. We will see later that hydrogen can even be made from fossil fuel (e.g.,coal), with disposal of the carbon dioxide at the source, thus avoiding the greenhouse effect. While decision-makers in the United States have so far not taken hydrogen as an energy vector seriously, countries such as Canada, West Germany and

Japan have made a profound commitment to hydrogen as an energy transfer medium for the future.

Their reasons for this commitment are multiple, and involve the philosophy given above, as well as political considerations such as possible interruption of Middle East oil supplies. When oil and gas start to deplete in first years of the next century, they will first run out for net hydrocarbon importers. Pollution from combustion of fossil fuels already has great social affects, particularly from the effects of acid rain. Indeed, the total "social costs" of consuming fossil fuels may amount to almost 12% of the GNP, about three times the selling prices of the fuels themselves as a fraction of total GNP. This 12% essentially represents a social "tax" on the economy as a whole (2). In addition, there is the effect of ejecting greenhouse gases, particularly CO_2 from fossil fuel use, into the atmosphere, whose long-term economic consequences have yet to be evaluated.

Future society will require electricity, with its convenience for immediate, efficient and clean end-use, in greater amounts than those used today as a percentage of total energy utilization. It will require a fuel for applications where storage is necessary. hydrogen is the only possible fuel for the long-term. Ideally, both hydrogen and electricity would be entirely produced from nuclear and/or direct or indirect solar sources (e.g., hydropower, wind, ocean thermal). Since coal is a major U.S. resource, an important alternative will be the coproduction of electricity from coal and water (6), with disposal of the carbon dioxide produced, in depleted oil or gas wells, or as a liquid in the deep oceans (this merely represents a speed-up of the natural process of the conversion of CO_2 to limestone). With the permanent disposal of CO_2 as outlined above:

- Coal could be the cheapest source of non-polluting hydrogen in the United States in the early part of the 21st century.
- Coal can help solve the greenhouse effect, not add to it.

Bearing in mind its high utilization efficiency, and taking into account the non-polluting nature of hydrogen and its very low "social

cost" compared with that of fossil fuels, hydrogen from renewables or coal (with CO_2 disposal), even though it will be more costly than today's fuels, may still be a future bargain both for its immediate user and for society as a whole.

In view of the above, it will be necessary to halt the direct burning of fossil fuels on a world-wide basis, allowing no further carbon dioxide to be released. While the use of biomass will allow carbon dioxide recycling, it is expected to make only a small contribution to the national energy economy, though it will be locally important (5).

A reasonable policy goal might be to institute a remedial policy to restrict mean climatic change to an increase of 1°C per century, which is within natural range. However, we must also bear in mind that the time for reaching temperature equilibrium from a given CO_2 perturbation has been estimated to be up to 100 years (4), the time required for the oceans to respond. Indeed, irreversible damage to the planet may have already been done.

Due to the difficulties of mathematical modeling of such a complex system as the oceans/atmosphere/biosphere, there has been some dispute concerning the future extent of greenhouse warming. However, some very convincing recent experimental data have been repoted from the joint French-Soviet project in ice cores from the Vosotok Anarctic Base (3), which show prehistoric atmospheric CO_2 concentrations varying between 190 ppm and 300 ppm over the time period 160,000 BP and 2000 BP. Using Vosotok surface temperatures determined by ice-core hydrogen-deutrium ratios as indicators of mean global temperature, these correlate well with ice ages and interglacial periods, respectively. It is profoundly disturbing that in only thirty years, atmospheric CO_2 concentration resulting from the increased burning of fossil fuels has risen from 300 ppm to 345 ppm. If fossil fuels continue to be used as the main source of energy, CO_2 concentration may as much as double by the middle of the next century. This is far more rapid

than any natural prehistoric increase, and even today's figures brings the CO_2 level well outside its natural envelope. If we continue to randomly discharge carbon dioxide, we may conclude that the globally averaged surface temperature will rise by several degrees in the decades ahead, which will dramatically change existing agri-ecosystems, affect the habitability of key population areas worldwide, and produce a rise in sea level. In addition, CO_2 is not the only greenhouse gas, though it may account for 75% of the total effect: Other infrared absorbing materials resulting from anthropogenic activity are also being discharged into the atmosphere, including methane and nitrous oxide, and halohydrocarbons, which also deplete stratospheric ozone. Even if CO_2 levels are controlled, the effect of the other gases will become proportionately more important.

The Clean Energy Research Institute (CERI, University of Miami), the Florida Solar Energy Center (FSEC), the Hawaii Natural Energy Institute (HNEI, University of Hawaii) and the Center for Electrochemical Systems and Hydrogen Research (CESHR, Texas A&M University), in conjunction with the Solar Energy Research Institute (SERI, Golden, CO), have received $2.4M, provided by Congress through DOE for R&D on hydrogen fuel from renewable resources for the long term.

We should bear in mind that this allocation of $2.4M is very small compared with the magnitude of the most important global problem that we face just after the year 2000: the remediation of the greenhouse effect.

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STATEMENT OF HERBERT M. BOYD
Submitted to the
Subcommittee on Energy Research and Development
of the
Senate Committee on Energy and Natural Resources
May 18, 1988

Mr Chairman, members of the Subcommittee, I am pleased to have this opportunity to present the views of the Alabama Power Company on the FY 1989 budget request for the Department of Energy's photovoltaic research and development programs.

I am Herbert M. Boyd, Technology Management Coordinator at the Alabama Power Company, a subsidiary of The Southern Company.

First I want to thank the Chairman and members of the Subcommittee for supporting photovoltaic research and development during past years.

The Department of Energy budget request for FY 1989 of $24.18 million for photovoltaic research and development is 31% lower than the $35 million appropriated for the current fiscal year. I fully realize that the administration's and Congress' goal for deficit reduction places severe limits on FY 1989 appropriations. However, the proposed $24.18 million is not adequate to carry on the minimum research and development programs that are essential for photovoltaics during FY 1989. The Department of Energy Civilian Research and Development Authorization Act for Fiscal Year 1985, H.R. 4505, as reported by the Committee on Science, Space and Technology, includes an authorization of $35 million for the photovoltaic energy systems program. This increase above the budget request is needed and we recommend a minimum authorization of $40 million with $36 million designated for core research programs and $4 million for PV USA.

The electric utility industry will be seeking new sources of energy by the mid-1990s and renewable energy technologies should be available for consideration at that time to help meet the United States' energy independence goal. We believe that the renewable

energy technology that offers the greatest promise as a source of economic, clean energy for the utility industry is photovoltaics. This belief is demonstrated by the Alabama Power Company building and placing in operation the world's largest amorphous silicon thin-film photovoltaic grid connected array. This 100KW demonstration unit is now producing enough power at the time of our system peak to supply the energy for 25 homes.

In addition to the $1 million spent on the above installation, Southern Investment Group, another subsidiary of The Southern Company, has invested $6.1 million in a joint venture with Chronar Corporation to build and put into operation a 1MW amorphous silicon photovoltaic cell manufacturing facility in Birmingham, Alabama.

The Department of Energy research programs have enabled the domestic photovoltaic industry to make steady progress in developing a clean, competitive energy supply alternative. Today photovoltaics are competitive with other energy sources at remote sites. The Coast Guard has installed more than 9,000 photovoltaic aids to navigation worldwide that will save an estimated $2 million per year in maintenance costs and between $2 and $3 million per year in battery costs. However, even though many advances have been made, there is still important research needed to further increase conversion efficiencies, improve reliability and reduce costs in order for photovoltaics to be a viable energy source for central power applications.

The United States is in a race with Japan, West Germany and other countries in the development of photovoltaics for central power applications by utilities. The winner of this race will be the country with the best technology and lowest cost and that country will have a worldwide market for its photovoltaic products. The U.S. utility industry does not want to import from other countries the photovoltaic products needed to meet the energy demands of the 1990s.

However, as Department of Energy funding for photovoltaic research and development fell from $153.2 million in FY 1981 to $35 million

for FY 1988, research and development funding in Japan, West Germany and other countries has increased. For example, Japan increased funding for photovoltaic programs from less than $5 million in 1980 to $53 million in 1988. Included in these Japanese fundings are expenditures for amorphous silicon research and development, which increased from $2 million in 1980 to $23 million in 1988. During the same period, United States expenditures for amorphous silicon research and development increased from $5 million in 1980 to $10 million during 1987 but fell to only $8 million in 1988.

Since 1981 amorphous silicon thin-film photovoltaics have increased from 3% of total photovoltaic world sales of 5MW to 40% of 29MW. We believe that amorphous thin films offer the best potential for central power applications for the utility industry and it is the technology we are using in our system. During the past year, with help from Department of Energy funding, efficiencies of more than 11% have been achieved with new thin-film materials. However, as methods are found to increase efficiencies in the laboratory, additional research and funds are needed to be able to use these new materials in low-cost, reliable, large area submodules. This research needs to be done in the United States.

In order for the United States to maintain the lead in developing more effective photovoltaics, we support the industry's request for a minimum of $40 million for FY 1989. We recommend $36 million for core research programs and $4 million, as a separate line item, for PV USA. Within the core programs we believe $30 million should be allocated for thin-film research and $6 million for collector research.

Thank you.

* * *

ALTERNATIVE BUDGET FOR ENERGY CONSERVATION FY 1989

OVERVIEW

April 1988

Organizations Endorsing the Alternative
Energy Conservation Budget for FY 1989

ALLIANCE TO SAVE ENERGY

AMERICAN ASSOCIATION OF RETIRED PERSONS

AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY

AMERICAN FEDERATION OF STATE COUNTY AND MUNICIPAL EMPLOYEES

AMERICAN GAS ASSOCIATION

AMERICAN INSTITUTE OF ARCHITECTS

AMERICAN PUBLIC POWER ASSOCIATION

CONSUMER ENERGY COUNCIL OF AMERICA

CITIZEN/LABOR ENERGY COALITION

ENVIRONMENTAL ACTION

ENVIRONMENTAL DEFENSE FUND

ENVIRONMENTAL POLICY INSTITUTE

FEDERATION OF AMERICAN SCIENTISTS

FRIENDS OF THE EARTH

NATIONAL AUDOBON SOCIETY

NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS

NATIONAL ASSOCIATION OF STATE ENERGY OFFICIALS

NATIONAL ASSOCIATION OF STATE UTILITY CONSUMER ADVOCATES

NATIONAL COMMUNITY ACTION FOUNNDATION

NATIONAL CONSUMERS LEAGUE

NATIONAL WILDLIFE FEDERATION

NATURAL RESOURCES DEFENSE COUNCIL

PUBLIC CITIZEN

RENEW AMERICA PROJECT

SIERRA CLUB

UNION OF CONCERNED SCIENTISTS

U.S. PUBLIC INTEREST RESEARCH GROUP

UNITED METHODIST CHURCH. BOARD
OF CHURCH AND SOCIETY

ALTERNATIVE BUDGET FOR ENERGY CONSERVATION FY 1989

OVERVIEW

INTRODUCTION

The Alternative Budget for Energy Conservation recommends a total of $439.2 million for Federal energy conservation programs, an 19.0% increase above FY 1988 appropriations (see tables on pages 2 & 3). State and Local Assistance programs would receive $247.1 million, while Conservation R&D would receive $192.1 million. In real dollars, this is less than was appropriated in FY 1986. The alternative budget represents a modest proposal for restoring balance to the federal energy budget. It should be viewed as a first step toward significantly higher levels of funding for energy conservation that sound energy and economic policy dictates.

The President's proposed FY 1989 Budget would cut conservation programs 74.2% below FY 1988 appropriation levels, from $368.3 to $94.9 million. State and Local Assistance programs would be reduced by 96% from $212.1 million to $8.6 million, and Research and Development (R&D) program funds would be cut 55.2%, from $156.2 million to $86.3 million. Unfortunately, these deep cuts reinforce a long-established trend of decreased federal funding for conservation programs. Conservation now only accounts for one-half of 1% of the Department of Energy's proposed $16.1 billion budget.

Energy conservation is the fastest growing energy source in the U.S. economy; energy efficiency improvements made since 1973 are now saving the U.S. an estimated $130 billion per year. These enormous savings are largely due to the private sector, which responded rapidly and effectively to the energy price rises of the 1970's. But the federal government also played an important role in fostering these improvements. In areas where there was little or no likelihood of the private sector making improvements, such as weatherizing low-income housing, the federal government took a lead role. In other areas, such as technology development, the federal government formed cooperative arrangements with private industry that led to important efficiency advances.

FY 1989 ALTERNATIVE BUDGET RECOMMENDATIONS

DEPARTMENT OF ENERGY

SUMMARY OF ESTIMATES BY APPROPRIATION BY MAJOR ACTIVITY
(dollars in thousands)

ENERGY CONSERVATION

I. ENERGY CONSERVATION R&D	FY 1980 Actual	FY 1986 Actual	FY 1988 Appropriation	FY 1989 DOE Request	FY 1989 Alternative	Alternative vs. FY 1988	Alternative vs. Request
A. Transportation	$109,500	$57,457	$51,828	$28,382	$55,100	+$ 3,272	+$ 26,718
New Initiatives			-0-	-0-	5,400	+ 5,400	+ 5,400
B. Industrial	58,200	40,708	33,094	16,452	32,600	- 494	+ 16,148
New Initiatives			-0-	-0-	4,100	+ 4,100	+ 4,100
C. Buildings and Community Systems	98,300	37,862	33,596	14,950	47,250	+ 13,454	+ 32,300
New Initiatives			1,050	-0-	8,700	+ 7,650	+ 8,700
D. Multi-Sector	77,800	25,922	29,003	24,157	34,075	+ 5,072	+ 9,918
New Initiatives			-0-	-0-	2,500	+ 2,500	+ 2,500
E. Policy and Management	N/A	1,726	1,662	2,386	2,386	+ 724	-0-
F. Facilities	-----	-----	6,000	-0-	-0-	- 6,000	-0-
Sub-Total, Conservation R&D	$343,800	$163,675	$156,233	$86,327	$192,111	+$35,878	+$105,784

(continued next page)

II. STATE AND LOCAL ASSISTANCE PROGRAMS	FY 1980 Actual	FY 1986 Actual	FY 1988 Appropriation	FY 1989 DOE Request	FY 1989 Alternative	Alternative vs. FY 1988	Alternative vs. Request
A. Institutional Conservation Program (Schools & Hospitals)	$143,800	$ 44,888	$ 25,156	$ -0-	$35,600	+ $10,444	+$ 35,600
B. State Energy Conservation Program (EPCA Grants)	37,800	17,903	9,519	-0-	18,800	+ 9,281	+ 18,800
C. Energy Extension Service	25,000	7,300	3,968	-0-	6,000	+ 2,032	+ 6,000
D. Weatherization Assistance Program	199,000	182,084	161,357	-0-	168,000	+ 6,643	+ 168,000
E. Territories Assistance	N/A	476	-0-	-0-	200	+ 200	+ 200
F. Program Direction	N/A	9,745	12,095	8,605	18,500	+ 6,405	+ 9,895
G. Other	26,200	N/A	N/A	N/A	N/A	N/A	N/A
Sub-Total, State and Local Assistance Programs	$431,800	$261,920	$212,095	$8,605	$247,100	+ $35,005	+$238,495
TOTAL, Energy Conservation	$775,600	$425,595	$368,328	$94,932	$439,211	+ $70,883	+$344,279

However, this rapid trend toward improved energy efficiency may have stopped. Preliminary data from the Energy Information Administration indicate that the amount of energy consumed per unit of GNP may not have gone down in 1987. If correct, this will be the first time that U.S. energy efficiency has not improved in over ten years. Given that we have sharply cut our investment in energy efficiency, this turnaround should not be a surprise. There is a substantial lag between the time we invest in the development of new technologies and the time we reap their benefits. Past investments in new energy efficiency technologies may have carried us through most of the 1980's, but sharp cuts in energy efficiency expenditures during these years will affect future improvements in energy efficiency. Perhaps we are seeing the first signs of that reduced investment.

It is time to revitalize the deteriorating federal commitment to energy efficiency. Successful and productive federal energy conservation programs deserve funding increases and will sow the seeds for future increases in energy efficiency.

ESTABLISHING FEDERAL ENERGY PRIORITIES

Federal energy appropriations should be based upon potential for meeting important national needs. The following are important issues the Congress should consider when funding DOE energy programs:

- *Meeting Energy Needs Cost-Effectively* - Numerous studies conclude that the U.S. could further reduce its annual energy bill from $360 billion to $280 billion or less by employing energy conservation technologies and measures that are less costly than acquiring energy from conventional supplies. For example, saving energy by installing low-emissivity windows -- an energy saving product developed through a federal program -- costs about $2 per million Btu of energy saved, which is less than half the cost of natural gas. These technologies and measures are also highly cost-effective for consumers.

- *Reducing Oil Imports* - Energy conservation can reduce oil imports and stretch the United States' diminishing domestic oil supplies. U.S. dependence on foreign oil has surged from 27% of oil consumption in 1985 to 37% by the end of 1987. In fact, oil imports accounted for more than 25% of the U.S. trade deficit in 1987. Oil imports would be even higher without the significant strides in energy conservation made over the last decade. If the U.S. economy still consumed oil and gas at the 1973 rate, we would be consuming an additional 13 million barrels of oil equivalent per day, almost half of OPEC's production capacity.

- *Improving America's International Competitiveness* - Continued advances in energy-saving technology can play a key role in assuring the competitiveness of U.S. industry in the world market. Over the past decade, American automakers lost one-fourth of the global market to fuel-efficient Japanese cars. A similar challenge to our domestic and international market is emerging from foreign competitors in lighting, heating and air conditioning, motors, appliances, manufacturing equipment, and industrial processes. Unfortunately, as the President's Commission on Industrial Competitiveness Report noted, America has recently lost global market shares in 7 out of 10 high technology market areas despite leadership in developing high technology products. R&D in energy efficiency can help reverse this trend and insure against further erosion of competitiveness. For example, a federal conservation program to develop gas-fired heat pumps, which are at least 50% more efficient than today's most efficient gas furnaces, is competing directly with a similar Japanese program.

- *Improving Environmental Quality* - Energy conservation reduces energy use and thus decreases environmental harm resulting from the exploration, production, transportation, and consumption of energy. A 1983 National Science Foundation report concluded that energy conservation provides the most important opportunity to ameliorate carbon dioxide accumulation -- the greenhouse effect -- caused primarily by burning fossil fuels. Recent studies have demonstrated that energy conservation can play a major role in reducing the cost of pollution abatement. Energy conservation can also play a significant role in reducing acid rain emissions, destruction of the ozone layer, thermal and solid waste, and nuclear waste.

- *Improving Quality of Life for Low-Income and Disadvantaged Households* - While energy prices are important for everyone, they have special importance for the disadvantaged. Increases in energy prices have a disproportionate effect on low-and fixed-income citizens. Low-income families generally have the least energy efficient homes. In 1986, low-income households used 14-15% of their income for energy bills, three times the national average. Weatherization programs can assist the neediest families and also extend the benefits of assistance programs.

RESEARCH AND DEVELOPMENT PROGRAMS

New R&D Initiatives - The Alternative Budget proposes seventeen new initiatives to augment existing lean research programs. In the Buildings and Community Systems Program, new initiatives include an effort to combine research on improving the efficiency of commercial buildings with efforts to improve the energy efficiency of federal buildings, which could ultimately save taxpayers hundreds of millions of dollars annually. In the Industrial program, a new initiative is proposed to improve the energy efficiency of glass processing, an energy-intensive process that desperately needs improvement. New initiatives for the Transportation Program include an effort to apply new glass technology from the buildings sector to transportation to reduce solar heat gain in cars and thus substantially reduce the amount of fuel consumed by auto air conditioners. In the Multi-Sector Program, a new initiative is proposed to evaluate and distribute information addressing environmental problems through improved energy efficiency. Recent research shows that incorporating energy efficiency improvements into pollution control programs can substantially cut costs of pollution control. For further information on R&D new initiatives, a complete list of titles is attached.

New Initiatives Request: $21.7 million.

Transportation - The Transportation Program develops advanced technologies for automobiles and light trucks, advanced battery designs for electric vehicles, and technological options that enhance fuel flexibility for alternative fuels such as methanol. Current research projects include development of gas turbine engines with greater fuel efficiencies than conventional engines, and engine parts that can withstand very high temperatures. DOE supports research through arrangements with industry and research institutions that contribute from 20-50% of costs.

Alternative budget request: $60.5 million.

Industrial - DOE's Industrial Program advances energy efficiency for many U.S. industries including chemicals, petroleum, metals, pulp and paper, food, textiles, and machinery. The competitiveness of many industries is directly tied to energy consumption because many of America's languishing industries are energy-intensive. The Industrial R&D program emphasizes cooperative government/industry efforts to identify technological needs for energy conservation and high priority projects that are not being pursued by the private sector. The program has been very successful in developing technologies that are now commercially available or just entering the marketplace. For example, an R&D project developed in conjunction

with United Merchants successfully demonstrated a process for finishing textiles that drastically reduces energy consumption and doubles the production rate. The process, known as foam finishing, has been widely adopted by the textile industry and had saved 3.6 trillion Btus of energy by 1987.

Alternative budget request: $36.7 million.

Buildings and Community Systems - The Buildings program supports research to better understand the nature of energy consumption in buildings; develop new technologies for building equipment and components (e.g. heat pumps, windows, and lighting); prepare better building design tools, standards and guidelines; improve the energy efficiency of existing buildings; and improve indoor air quality. The Community Systems part of the program develops new methods to improve energy efficiency and management at the community level, such as district heating and cooling systems. Buildings and community systems R&D provides enormous savings by accelerating the commercialization of new technologies. For instance, a one-time Federal investment of $5 million in the development of more efficient lighting controls (solid-state ballasts) and windows that reflect heat (low-emissivity windows) is projected to save users $38 billion over the five years by which the federal government advanced commercialization of these products - a return on Federal investment dollars of 7000 to 1.

Alternative budget request: $56.0 million.

Multi-Sector - This program conducts basic research applicable to all consuming sectors on combustion and thermal sciences, materials, biological and non-biological chemical conversion (such as ethanol production), and tribology (the study of friction, wear, and lubrication). In addition, the program promotes the development of promising technologies that probably not be commercialized without federal funding. The multi-sector budget also includes support for the National Appropriate Technology Assistance Service (NATAS), which provides technical assistance to individual homeowners, small business owners, and others.

Alternative budget request: $36.6 million.

STATE AND LOCAL ASSISTANCE PROGRAMS

Institutional Conservation Programs (ICP) - Also known as the Schools and Hospitals program, ICP was established to encourage energy conservation initiatives in public and non-profit institutional buildings where energy consumption represents a significant percentage of operating budgets. Through FY 1987, the program has awarded 21,000 grants for energy conservation projects in over 59,000 schools and hospitals. The program has been highly successful. For example, each program grant dollar made in California is estimated to save $11 worth of energy. $64 million in conservation investments made in California during 1979-84, half of which were federal grants, now produce annual energy savings of more than $25 million. In Washington State, $12 million worth of ICP grants have resulted in $4 million worth of annual energy savings.

Alternative budget request: $35.6 million.

State Energy Conservation Programs (SECP) - SECP supports innovative energy efficiency programs for all sectors of the economy to help states meet localized energy needs, while also benefiting local economies. For example, the Alaska Department of Community and Regional Affairs developed an energy mortgage valuation program to encourage the construction of more efficient homes by rewarding buyers of these homes a 2% credit on the debt-to-income ratio of their mortgage loans. The New York State Energy Office developed a below-market interest rate loan program to finance energy efficiency improvements for small industrial and commercial firms, not-for-profit organizations, and owners of multi-family dwellings. Arizona initiated a solar development plan that encourages solar energy business development and the utilization of solar energy for all sectors of the economy. Cumulative energy savings from SECP activities totaled approximately 670.7 million barrels of oil equivalent between 1977 and 1983.

New programs recommended for the FY 1989 State Energy Conservation Program include: 1) expanding the state role in helping establish energy efficient technologies in the marketplace; 2) enhancing state energy emergency planning capabilities; and 3) encouraging new state initiatives that include innovative energy financing, integrated (least-cost) energy planning, new programs in transportation and industrial energy efficiency, and promoting alternative transportation fuels and renewable resources.

Alternative budget request: $18.8 million.

Energy Extension Service (EES) - EES provides information and technical assistance for small businesses, local governments, and homeowners on energy conservation and renewable energy options. EES programs are diverse and innovative. For instance, the Washington Energy Extension Service has developed an irrigation system audit guide and a computer program on water scheduling to help farmers reduce irrigation energy costs. The Maryland Small Town Energy Education Program has helped 30 towns design economical conservation strategies by providing free energy audits of their municipal buildings and water treatment plants and advising them on street lighting efficiency improvements. EES programs leverage federal dollars with local funds to achieve maximum conservation benefits.

Alternative budget request: $6.0 million.

Weatherization Assistance Program (WAP) - WAP was developed to improve the energy efficiency of low-income housing, particularly those of the elderly and handicapped, and to reduce the energy costs of low-income consumers. National surveys have concluded that an average WAP expenditure of $1,100 per dwelling reduces annual household energy bills an average of 10-20%, making room in household budgets for other essential goods and services. While it is estimated that approximately 17.6 million households are eligible to receive assistance under WAP, only 3 million low-income homes were weatherized as of 1986. FY 1988 funding will enable states to weatherize only 150,000 dwellings. A modest goal of completing half of the eligible single-family buildings and priority multi-family buildings would cost approximately $7.5 billion.

Alternative budget request: $168.0 million.

CONCLUSION

We urge the Congress to reject the Administration's minimal request for Federal energy conservation programs and provide funding commensurate with national needs and energy efficiency opportunities. As stated above, energy conservation is the easiest and most economical way to meet U.S. energy needs. It reduces oil imports, improves U.S. international competitiveness, improves environmental quality, and helps reduce the burden on those with low and fixed incomes. The Congress is further requested to fund the promising new R&D initiatives that will assure future energy efficiency gains will match those of the past dozen years.

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ENERGY CONSERVATION R&D

NEW INITIATIVES

TRANSPORTATION PROGRAMS

- Study of Federal/Private Cooperative R&D Cooperative on Medium-Term Fuel Efficiency Technologies ($300,000)
- Advanced Ceramic Production Processes ($500,000)
- Prototype of Passenger Car Adiabatic Diesel Engine ($1,500,000)
- Advanced Windows for Passenger Vehicles ($600,000)
- Transportation Applications for Superconductors (Magnetically Levitated) ($500,000)
- Advanced Fuel Cells for Transportation ($1,500,000)
- Advanced Continuously Variable Transmissions (CVT) ($500,000)

INDUSTRIAL PROGRAMS

- Glass Processing ($400,000)
- Composite Ceramic Materials Research ($2,500,000)
- Ceramic Materials Applications to Stationary Gas Turbines ($1,200,000)

BUILDINGS AND COMMUNITY SYSTEMS PROGRAMS

- Commercial Retrofit/Federal Retrofit Support Program ($3,200,000)
- New Technology and Monitoring Center ($800,000)
- Industrial Housing ($1,500,000)
- Weatherization Research Program ($2,000,000)
- Desiccant Cooling Research ($400,000)
- Advanced Energy-Efficient Appliances ($800,000)

MULTI-SECTOR PROGRAMS

- Applied Computational Science ($500,000)
- Database on Cost of Abating Pollutants Through Efficiency Improvements ($500,000)
- Advanced Monolithic Solid Oxide Fuel Cell or Corrosion Resistant Metals ($500,000)
- Electrochemistry ($1,000,000)